SCIENCE

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CONTENTS:

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XLIV. MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, SPRINGFIELD, MASS., AUG. 28th–SEPT. 4th, 1895.

IN 1859 the American Association assembled for its thirteenth meeting in Springfield. After the lapse of thirty-six years the Association has again met in the metropolis of western Massachusetts, this time for its forty-fourth annual gathering, five meetings having been passed on account of the Civil War.

Geographically, Springfield is well located for a place of meeting, being within easy reach of a large proportion of the members of the Association. For some reason, perhaps, the unusually late date of holding the meeting, the hopes of officers and local committee as to attendance were not realized, it having been the smallest meeting held in the eastern section of the country since that of Saratoga in 1879, and having but slightly exceeded the meetings held in the West. The number of members registered was hardly double that of the earlier Springfield meeting, when 180 were present.

The uncertainty until a late date as to where the meeting would be held, it having been hoped that the railroads would make satisfactory rates to San Francisco, may also have contributed to the smallness of the meeting.

But if the attendance was not what might have been wished, the arrangements by the local committee have rarely been better made. Outside of a University town it is rarely possible to have all the audience rooms in one building, but at Springfield all were in such close proximity that little inconvenience was experienced in going from section to section and to the offices and reception rooms. Every convenience was provided for the members, and the courtesies of the citizens of the city are worthy of special mention. It is, however, unusual that the immediate vicinity of the place of meeting is so meagerly represented among

the members. Of the whole number registered, only 15 were from the city of Springfield and hardly more than half a hundred from the entire State of Massachusetts; more than half of these, too, were elected at the present meeting.

While these strictures must in fairness be passed upon the meeting, the work in the individual sections was probably above the average. The number of papers presented—over two hundred—was very large and many of them were of unusual value and interest. This was particularly true in the Sections of Chemistry and Anthropology, and members were heard to characterize the meeting as far as regarded these sections as the most helpful and best ever held. In the Chemical Section this was due to the labors of the Vice-President and Sectional Committee in preparing the program long in advance of the meeting. In this connection it may be said that of the 184 new members elected 40 belong to section C, and 21 out of 58 fellows elected at the Springfield meeting are members of the the same section. At the same time the American Chemical Society is by far the largest (over 900 members) and perhaps the most active of the Affiliated Societies. In this case it seems as if the Affiliated Society is directly conducive to the prosperity of the Section of the Association. The opening session of the Association was held in the Y. M. C. A. Hall on Thursday morning. In calling the meeting to order the Permanent Secretary, Prof. F. W. Putnam, read a letter from the President, Dr. D. G. Brinton, announcing that owing to the continued serious illness of his wife it was impossible for him to return from Europe in time for the meeting. In Dr. Brinton's absence, the Senior Vice-President, Prof. Wm. H. Brewer, of New Haven, was called to the chair, and referring in a few well-chosen words to the labors of the President-elect in his well-known determinations of the composition of water, introduced Prof. Edward W. Morley, of Cleveland, as President of the forty-fourth meeting of the Association. After an invocation by Rev. Bradley Gilbert addresses of welcome were delivered by ex-Lieutenant-Governor W. H. Haile, and Mayor Charles L. Long. This latter address, contrasting well the periods at which the two Springfield meetings were held, was as follows:

More than a third of a century has passed away since this Association last met in this city, on the 3d day of August, 1859, for the purpose of holding its 13th gathering. Prof. Stephen Alexander, that distinguished astronomer whose writings attracted the attention of scientific scholars of this country and of other lands, presided at the meeting. The political and scientific changes which have taken place during the period that has passed have been many, and they have been as remarkable as they have been numerous.

When that convention assembled, human slavery was a legalized institution in the Southern States, and the great question of its extension into the Territories and of their admission into the Union cursed with its blight agitated the people. Two months had scarcely passed after the Association adjourned, before the country was convulsed with excitement over the insurrection at Harper's Ferry, and within two years the storm which had for so long been gathering and which was to settle forever the great questions of State rights and of human slavery in this country broke with terrific fury upon our beloved land, drenching it in fraternal bloodshed and in a conflict unequal in its magnitude and unsurpassed in the importance of the results achieved.

No doubt the learned men who assembled at that gathering were proud of the success which had thus far drowned scientific investigation, and gloried in the great ad-

vance which had been made. But so great have been the discoveries which have followed, and so wonderful have been the changes which these discoveries have wrought, that we can hardly appreciate that many of the great scientific truths of to-day were but cautiously advanced theories at that time.

It was during the year preceding that meeting that the paper of Wallace 'on the tendency of varieties to depart indefinitely from the original type' and Darwin's paper 'on the tendency of species to form varieties' were read, simultaneously, before the Linnæan society. On the first of October following that meeting Darwin published his 'Origin of Species,' which more than a decade later caused the French Academy to reject him as a candidate for membership by a vote of more than two-thirds, one of its menbers declaring that the 'Origin of Species' was 'a mass of assertions and absolutely gratuitous hypotheses, often evidently fallacious.'

Truly, 'the stone which the builders refused is become the headstone of the corner,' for the doctrines of Darwin's work are now recognized and accepted by the learned and scientific of the civilized world; and evolution, which was for years scorned and rejected not only by the great majority of the scientific, but by pretty much everybody whose views upon the subject were entitled to weight, is now almost universally accepted.

During this period the doctrine of spontaneous generation received the aggressive attention of scientists. The views of the learned Pasteur, which were opposed to this doctrine, were contested, and were supposed to have been refuted by the experiments of Wyman. The theory of spontaneous generation is no longer accepted, but out of the agitation which it created, was born the new science of bacteriology.

Indeed, during the period of which I am speaking, the progress in geological, zoölogical, physiological and astronomical science, in chemistry and in physics, has been marvellous. The wonderful development and utilization of electric forces, which forms such a marked demonstration of the value of scientific research, was not then dreamed of. Even the Atlantic Cable had not been successfully laid, and the results of the wonderful inventions of Edison, of Bell and of many others of the great discoverers and inventors of the electrical world were not for a moment contemplated.

The doctrine of the antiquity of man, which sought to place and which now places his origin far back beyond the period of 6000 years, which was then zealously contested, is now not only adopted by scientists, but is accepted complacently by all the well-informed without any shock to their religious feelings.

These great advances, which have entertained, enlightened and improved the mind, and added greatly to the comfort, happiness and welfare of mankind, are the result of investigation and study by men such as those of you whose lives are devoted to scientific research and who are here assembled as an association under a constitution proclaiming its object to be: "By periodic and migratory meetings, to promote intercourse between those who are cultivating science in different parts of America, to give a stronger and more general impulse and more systematic direction to scientific research, and to procure for the labors of scientific men increased facilities and a wider usefulness."

You have assembled in a city which has sprung from one of the earliest settlements in this Commonwealth. Here, 260 years ago, the rude cabins of the first white settlers were erected. Here our Puritan ancestors found in large numbers, contented and happy in their savage freedom and ignorance, the American Indian, from whom

they obtained by purchase the land upon which our city is built and with whom, for a period of 40 years, they lived in interrupted peace.

Here, as declared in the first of the articles adopted for their future government, they laid the foundation of their future growth and prosperity on the principles of the Christian religion; and here, as a result of those principles, the industry and honesty of our predecessors and the aggressive qualities of our people, we have, to-day, a well-governed, a prosperous and beautiful city, surrounded by natural scenery which excites the admiration of all lovers of nature; a city which, in population, in trade and in its industries is deservedly recognized as the metropolis of western Massachusetts.

I am greatly honored in being the representative of such a city, and as its representative in extending to you a cordial welcome to our borders, to an association with our people, to an examination of our institutions and to such entertainment as we may be able to provide for you; and I assure you that by your presence our citizens appreciate that they are greatly honored by reason of your high standing as individuals, your professional attainments, and the reputation of your Association, whose illustrious work in the past will be, I am sure, excelled by the results which will crown its labors in the future.

Replying to ex-Lieutenant-Governor William H. Haile, President of the Local Committee, and His Honor the Mayor, Charles L. Long, who had welcomed the Association, Mr. Morley said:

GENTLEMEN: That which you say to us of the beauty of Springfield and of the scenery of this fertile valley commands our cordial assent. We listen with delight to the survey of the general progress of science since our last meeting in your city, which you state with so much fairness, and with so much justice and so much breadth of view. But best of all are the words of hearty and generous welcome which are so grateful to us, because they assure us of a profitable meeting and promise us delightful intercourse with your citizens.

Massachusetts is the last place on the face of the earth where this Association could possibly be made to feel like a stranger and an alien. It was an act of your Legislature which incorporated us. Of our forty-two Presidents, Massachusetts can fairly claim as her citizens not less than seven, or one-sixth of the whole number. Almost from time immemorial one Permanent Secretary after another has been elected from Massachusetts. We have met at Cambridge, at Springfield, at Salem, at Boston and again at Springfield.

Let me interrupt for a moment my reply to your welcome. Some of us, for whom the backward view covers the larger part of the visible heavens, would recall something of our meeting here in 1859. There are now on our list the names of twenty-one who were members of our Association at that time. Its President was that Professor Alexander, of whom the President of the Local Committee has already spoken. The Vice-President (there was but one), was a most distinguished citizen of Massachusetts, who was the first President of the Society which was the parent of our own, known all over the world for his masterly labors in geology, Dr. Edward Hitchcock, of Amherst. The General Secretary and the Permanent Secretary were Professors Joseph Lovering, of Cambridge, and William Chauvenet, of St. Louis.

Of those who became members of this Association at our Springfield meeting, eighteen have maintained their membership to the present time or to their decease. But four of these are living. Professor G. F. Barker is known to us all; some of us think his compendium of physics is the best

in the English language. Dr. Samuel H. Scudder is known for his work on the bibliography of science, and for his many labors in entomology; this Association has published a memoir of his on fossil butterflies. Professor Henry A. Ward is again here making an exhibit of mineralogical and geological specimens, which is a source of much pleasure to many of our own number and of the public. Of those whom we have lost I may mention Henry B. Mason, of Troy; Lewis M. Rutherford, of New York, and James Craig Watson, of Ann Arbor.

The number of our members in attendance at that meeting was large; we may be sure that when such officers presided and such men became members, the meeting cannot but have been a successful and profitable one.

Your welcome was especially grateful to us, because it exhibited an appreciative interest in us and in our work. Such an appreciative interest has been exhibited in other ways. On eight dates during the summer I have been where I read a Springfield morning paper. Four of these papers contained articles, of at least a half a column, written with dignity, with adequate information, not without literary graces of style, which were devoted to this Association; therefore, in the judgment of a practiced editor, many of those who read your daily papers have some intelligent interest in our Association, its history, its object, its methods, in the history of our sister Associations in other countries.

Your words of welcome express the same appreciative interest; they confirm the same favorable impression we have received, and fill us with pleasurable anticipations.

We know something of Massachusetts, and of what sort of welcome we might reasonably expect. We know of Massachusetts, though not many of us are its citizens or its children. In the intention of its founders, our Association includes the whole of this continent; in accomplished fact our membership represents perhaps every State of this Union and every province of the great Dominion north of us, and a few from countries or islands to the south of us. Many of us have, therefore, grown up under other influences than those of Massachusetts. We come from other strains of colonization. We owe allegiance to other local institutions. We have learned to revere other local traditions.

But we all cordially agree in saying that, in all those things in which the citizens of a Commonwealth ought to feel the highest pride, Massachusetts is unsurpassed. No contributions to political thought have been greater or better than hers; no moulding of political or social institutions has been wiser than hers; nowhere on the continent has literature touched a higher level than on her shores or her western hills; nowhere has high thinking been better combined with living made subservient to the intellectual life.

We see these things; we admire, but we do not wonder, for we know the stock which first settled Massachusetts Bay. Putting religion in a place, some think, too high for mortal powers, they came from school and college in the old world, and brought to the new a profound sympathy with learning and scholarship and literature. These men, their spirit, their foundation of universities, their keen intellectual life have made this Commonwealth one whose guests we are proud to be, sure of welcome, sure of *appreciative* welcome, which receives us for what we are.

We are an association for the advancament of science. Some of us advance science chiefly by expressing our interest in it. Some of us, burdened with much teaching, find in that the limit of our opportunities. But some of us try to enlarge the borders of science and to add to the world's stock

of knowledge. These last ought to be considered as the more important part of our society and as the proper index to its character.

Now, the advancement of science ministers chiefly to purely intellectual wants. Science is not the apple tree nor the vine, bearing fruit for the body. It is the elm or the lily; carefully nurtured, highly prized, because it ministers to higher necessities, to intellectual or æsthetic wants. Of course, many purely scientific discoveries have become the basis of inventions which have conferred enormous material benefits; some value science chiefly or wholly because of the promise of further material advantages; they esteem the elm because sometime it may perhaps support the vine. But we, who love science and give to it much labor and weariness, value it chiefly because of the intellectual benefits which it confers on our race. And in this ancient Commonwealth we feel that you value every source of intellectual uplifting and intellectual inspiration. We think, and I am sure so do you, that this world is a better place for men to live, now that we know its size, even if we can make no material profit from the knowledge. We think, with you, that this continent is a better home for intellectual beings, now that the history of its formation has been made out by the combined labors of so many eminent geologists, and has been told with such a wealth of learning and such skill of exposition by one of our past Presidents, who has been taken from us since we last met, not till he had completed his work. The knowledge of the distance of the sun makes no one richer or warmer, but it makes some of us happier, by satisfying the ennobled and ennobling curiosity which seeks to learn all which is now unknown.

So we who are fascinated with science justify our devotion to it by the intellectual benefits which our devotion confers on our fellow men. So we ask you to receive us, not as engineers, promising new structures or flying ships; not as inventors, creating new sources of income and new comforts; not as ethical teachers, for science cannot change human natures or the social order; not even as those who would make two ears of corn grow where one grew before; but as those who would make two lilies grow for one in the garden of the Nation's intellectual life.

We wish we could make some return for your generous welcome, in kind, in any way; but we cannot. We can only thank you; we thank you again, and again.

On the afternoon of Thursday the addresses of the Vice-Presidents were delivered, and in the evening the Presidential address of Dr. D. G. Brinton, on the 'Aims of Anthropology,' was read in the Court Square Theater by the General Secretary. As these addresses are published in full in the columns of Science, no further reference is made to them.

Three public lectures, complimentary to the citizens of Springfield, were given during the week. On Friday evening Professor Wm. M. Davis, of Harvard University, lectured on 'The Geographical Development of the Connecticut Valley,' a large and evidently appreciative audience following with interest the story of the valley, and enjoyed the accompanying sterioptieon views.

On Tuesday evening the City Hall was almost filled to hear Mr. Cornelius Van Brunt's lecture on 'The Wild-flowers of the Connecticut Valley,' and more especially to see the beautiful floral photographs, exquisitely colored by Mrs. Van Brunt, projected by the stereopticon. The flowers, which comprised our common favorites, had evidently been photographed against an absolutely black background, and then the positive lantern slide colored with great delicacy and fidelity to nature. The flowers

stood out upon the screen with a beauty that can hardly be exaggerated; they were most enthusiastically received by the audience.

On Wednesday afrernoon, Professor A. S. Bickmore lectured on the 'Illustrative Method of Teaching Geography and Zoölogy at the American Museum of Natural History, in New York City.' This lecture, like its predecessors, was illustrated by beautiful stereopticon views.

Evident emphasis was laid upon the social side of the Springfield meeting. While unquestionably many of the members attend almost exclusively on account of the papers and discussions of the meetings of the several sections, there is a large number who would lay equal stress on the value of the gathering in bringing together socially specialists in very varied fields of knowledge, and of giving them opportunities for interchange of ideas; the specialist needs more breadth and he gains it by contact with those outside of his immediate field. The importance of this as an aim of the Association is often overlooked, but should not be. On Wednesday evening the Association was invited to a reception at the new Art Museum, the doors of which were that night for the first time opened to the public. The building is a beautiful one and a fitting place for housing the collection which in a a number of departments is of great value. On Thursday evening, at the conclusion of the Presidential address, the Ladies' Reception Committee gave a reception to the Association at the City Hall. The hall was tastefully and appropriately decorated, the music by two orchestras well selected and rendered, the collation thoroughly appreciated, and the efforts of the committee in charge to make the occasion enjoyable to all present were eminently successful. On Monday, late in the afternoon, lawn receptions were given to the several sections by ladies of Springfield, which were largely attended and enjoyed.

The whole day on Saturday was as usual devoted to excursions in the vicinity of Springfield. The college party, which included most of the members present, left early in the morning for Amherst, a small number however leaving the party at Holyoke in order to visit Mt. Holyoke College at South Hadley. Most of the party kept on to Amherst, where they were taken in carriages to either Amherst College or the Agricultural College,as they wished. Several hours were spent in examining the buildings and collections. At Amherst College much attention was attracted by the new chemical and physical laboratory erected under the direction of Professors Hains and Kimball, and by the fossil footprints collected by President Edw. Hitchcock. At the Agricultural College the Insectary, one of the three in existence, was considered the most notable feature. From Amherst the party went to Northampton, where a collation was served at the town hall by the citizens of the place. Unfortunately at this time the rain which had threatened all the forenoon now began, and somewhat interfered with the enjoyment of the afternoon. The party visited Smith College in carriages and many of them went to the numerous places of interest in the suburbs of Northampton. In spite of the weather, the day was one of much pleasure and profit to the participants in the excursion. Sunday, though quietly spent, was not devoid of scientific interest to the members of the Association. Several pulpits were filled by visiting members and a number of sermons on subjects of scientific bearing were preached in various churches. In the evening a union meeting was addressed by a number of members of the Association, and in the afternoon the usual Association prayer meeting was held at the Y. M. C. A. rooms. Returning to the more direct work of the Association, each morning a general session was held at ten o'clock, and the

final session was held on Wednesday evening, September 4. At these general sessions all business transacted by the Council was announced and their recommendations were considered by the Association. The more important items of business should be enumerated. After a prolonged discussion on the recommendation of the Council to change the name of Section I from Economic Science and Statistics to Sociology, the Association voted that the Section should be called *Economic and Social Science*. The Association declined to form a Section of Geography, letting Section E remain *Geology and Geography*.

Grants were made from the Research Fund as follows: $100 to Professor William A. Rogers, of Colby University, for continuing the work of Professor Morley and himself on the measurement of the expansion of metals by means of the interferential comparator; $100 to support a table at the Marine Biological Laboratory at Wood's Holl, the same to be under the direction of Vice-Presidents of the sections of zoölogy and of biology ex-officio, and of Professor C. O. Whitman, of the University of Chicago; $250 towards the support of the International Bibliographical Bureau at Zurich, Switzerland. This bureau is the result of the work of an American zoölgist, Dr. H. H. Field, and aims to prepare a current subject index of the publications in zoölogy. Owing to a financial stringency in the treasury of the Association it was felt necessary to curtail grants and other expenditures, and in view of this a number of members and friends subscribed several hundred dollars for the needs of the Association, and the hope was expressed that others will make this sum up to at least one thousand dollars.

It was decided to deposit the Library, which consists of several thousand volumes, mostly exchanges, with the University of Cincinnati, where it will be available to the members and fellows for direct consultation, or by mail, or express. The University of Cincinnati has offered to keep it in their new building and to bind within the next five years all the volumes, nearly three-fourths, which are now unbound. A card catalogue of the Library will be made, and it is hoped that the members and fellows will utilize the valuable publications in the Library. Professor J. U. Lloyd, of Cincinnati, and his brother have also in this connection offered to make their Botanical and Pharmaceutical Library accessible to the Association. This Library is probably the most complete on the continent in these subjects and is being constantly added to.

Professor Benjamin Apthorp Gould, of Cambridge, and Professor Rudolph Leuckart, of Leipzig, were elected to Honorary Fellowship in the Association.

The Sectional Committees of each Section were instructed to make efforts to have the program for their respective sections for the next meeting prepared as far as possible in advance, and the provisional programs will be distributed to the members at least a month before the time of meeting. It was felt that the experience of the Section of Chemistry showed that this would add much to the interest and profit of the meeting.

The election of officers for the meeting of 1896 resulted as follows:

President, Edward D. Cope, of Philadelphia.

Vice-Presidents, A. Mathematics and Astronomy, Wm. E. Story, of Worcester, Mass. B. Physics, Carl Leo Mees, of Terre Haute, Ind. C. Chemistry, W. A. Noyes, of Terre Haute, Ind. D. Mechanical Science and Engineering, Frank O. Marvin, of Lawrence, Kans. E. Geology and Geography, Ben. K. Emerson, of Amherst, Mass. F. Zoölogy, Theodore N. Gill, of Washington, D. C. G. Botany, N. L. Britton, of New York City. H. Anthropology, Alice C. Fletcher, of Washington, D. C. I. Economic and Social Science, William R. Lazenby, of Columbus, O.

Permanent Secretary (for 5 years from 1894), F. W. Putman, Cambridge, Mass.

General Secretary, Charles R. Barnes, Madison, Wis.

Secretary of the Council, Asaph Hall, Jr., of Ann Arbor, Mich.

Secretaries of the sections, A. Mathematics and Astronomy, Edwin B. Frost, of Hanover, N. H. B. Physics, Frank P. Whitman, of Cleveland, O. C. Chemistry, Frank P. Venable, of Chapel Hill, N. C. D. Mechanical Science and Engineering, John Galbraith, of Toronto, Can. E. Geology and Geography, A. C. Gill, of Ithaca, N. Y. F. Zoölogy, D. S. Kellicott, of Columbus, O. G. Botany, George F. Atkinson, of Ithaca, N. Y. H. Anthropology, John G. Bourke, U. S. Army. I. Economic and Social Science, R. T. Colburn, of Elizabeth, N. J.

Treasurer, R. S. Woodward, New York, N. Y.

Invitations to hold the meeting of next year at St. Paul, Indianapolis, Colorado Springs and Buffalo were presented. Buffalo was selected, partly for the reason that there has come to be a sort of precedent for a meeting at Buffalo every ten years. The Association met at Buffalo first in 1866, the first meeting after the opening of the war; 1876 and 1886 saw the Association again there, and now in 1896 the visit to Buffalo will be repeated. It was also kept in mind that a strong effort is being made to have the British Association meet at Toronto in 1897, and that the west would furnish desirable places for a joint meeting of the two Associations.

Much more debate was occasioned in selecting the date for the next meeting. The meeting of this year, beginning as it did the fifth week in August, was felt to be too late, the early opening of the schools and some colleges preventing the attendance of many teachers. This year the meeting opened on Thursday; sections met on Friday; Saturday was devoted to excursions, and the Sections renewed their meetings on Monday. The break of two days was felt to be detrimental to the interests of the Association. The Council proposed that the first meeting and Vice-Presidential and Presidential addresses be on Monday, leaving four days of continual session for section work, and then at the close Saturday is left for excursions. Many of the members, however, felt that Tuesday would be the best day for opening, as travel on Sunday could be better so avoided. After prolonged argument the recommendation of the Council was adopted, and the meeting of 1896 will open at Buffalo at 10 A. M. on Monday, August 24th. It is hoped by this arrangement to avoid the considerable exodus of members which takes place under the present custom on Friday night. The subject is complicated by the Affiliated Societies, which now meet for the most part on Monday prior to the opening of the Association, and some of whose members desire to get away before it closes.

The relation of the Affiliated Societies has occasioned an increasing amount of discussion, some holding that they are very helpful to the Association, while others see in them a cause of diminishing interest in the Association. A committee was this year appointed to consider broadly the policy of the Association and its relation to the Affiliated Societies, and to suggest methods of improving the present state of affairs.

The close of the last session of the Association was marked by the presentation of a resolution of thanks, which was seconded with appropriate remarks by a number of members of the Association, and ably replied to by ex-Lt. Gov. W. H. Haile. Thus ended a meeting which, if small in number, was nevertheless one of the most successful and helpful meetings which the Association has known.

JAS. LEWIS HOWE,
General Secretary.

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*THE RELATION OF ENGINEERING TO ECONOMICS.**

IN the first page of Mr. J. R. McCulloughs 'Introductory Discourse' (published

* Vice-Presidential Address delivered before Section D, Mechanical Science and Engineering, of the American Association for the Advancement of Science, at Springfield, Mass., Aug. 29, 1895.

in 1828) to his edition of Dr. Adam Smith's work, 'An Inquiry into the Nature and Causes of the Wealth of Nations,' he gives one of the best definitions we have of the science of political economy. "Its object," he says, "is to point out the means by which the industry of man may be rendered most productive of those necessaries, comforts and enjoyments which constitute wealth; to ascertain the proportion in which this wealth is divided among the different classes of the community, and the mode in which it may be most advantageously consumed."

The definition of engineering given by Tredgold, and incorporated into the charter of the British Institution of Civil Engineers, is 'The art of directing the great sources of power in nature for the use and convenience of man.' Rankine says: "The engineer is he who by art and science makes the mechanical properties of matter serve the ends of man."

Mr. George S. Morison, President of the American Society of Civil Engineers, in his address at the convention of the Society in June this year, says:

"Every engineering work is built for a special ulterior end; it is a tool to accomplish some specific purpose. Engine is but another name for tool. The highest development of a tool is an engine which manufactures power."

Comparing the above definitions of political economy and of engineering, we find they are closely related. Political economy, according to McCullough, points out the means by which the industry of man may be rendered most productive of wealth. If we asked the merest tyro in knowledge of human industry by what means industry might be rendered most productive, he would naturally answer, 'by the use of tools.' The engineer is the tool builder. His best work is the building of an engine which manufactures power, makes industry most productive and manufactures commodities which are the elements of wealth. Political economy, which points out the means by which industry may be made most productive, should, therefore, point out tools and engines. But, strange to say, the writers on political economy have almost entirely neglected to point out those means. Their 'dismal science,' as it is called, generally points out everything but tools and engines. It treats of buying and selling, of supply and demand, of rents, interest and wages, of tariffs, of money and currency, of land values, taxes, and what not; but, with rare exceptions, does not mention engineering, which is the most potent force in the economics of the nineteenth century.

Adam Smith, the first great English writer on political economy, writing in 1776, when he was, of course, not to be blamed for knowing nothing of the engineering of this century, said: "The greatest improvement in the productive power of labor, and the greater part of the skill, dexterity and judgment with which it is anywhere directed or applied, seem to have been the effects of the division of labor." He gives a famous instance of the division of labor in the manufacture of pins. One man, he said, might with difficulty make one pin a day, and certainly could not make twenty. But as the manufacture was carried on in his day, by division of labor one man draws out the wire, another straightens it, a third cuts it, a fourth points it, a fifth grinds it at the top for receiving the head, and so on, dividing the labor up among ten men, and eighteen different operations. Those ten men thus made between them 48,000 pins per day. Most writers on political economy have followed Adam Smith, and given division of labor the credit for making the greatest improvement in production, and neglected the still more important improvement, the introduction of machinery, by which the labor of ten men was all done by

a machine with one man tending it. But I find that Robert Ellis Thompson in his work on political economy (1875) mentions the case of the pin industry in its modern phase. He says: "An inventive mechanic has put together a machine that only needs to be fed with wire, well oiled and supplied with steam power, to turn out complete pins, sort them, and even thrust them into the papers in the right numbers and in straight rows."

The example of the pin industry may be taken as representative of what has taken place in every branch of productive industry. By the use of the steam engine and of other machinery the productive power of human labor has been increased a thousand fold, and engineering thus becomes the most important force which has caused an industrial and economic revolution throughout the civilized world, and the one subject of all others which should be discussed by a political economist.

Political economy being broadly the science of wealth, and since wealth is property, and property, according to some writers of the socialist school, is robbery, it may be well to get our bearings here, and see whether wealth is a thing to be desired or not. I quote here the words of Mr. McCullough in his 'Introductory Discourse,' above mentioned, and without further argument may say, that I agree with him entirely: "The acquisition of wealth is not desirable merely as the means of procuring immediate and direct gratification, but as being indispensably necessary to the advancement of society in civilization and refinement. Without the tranquillity and leisure afforded by the possession of accumulated wealth, those speculative and elegant studies which expand and enlarge our views, purify our taste, and lift us higher in the scale of beings, can never be successfully prosecuted. It is certain, indeed, that the comparative barbarism and refinement of nations depend more upon the comparative amount of their wealth than on any other circumstance. It is impossible to name a single nation which has made any distinguished figure either in philosophy or the fine arts without having been at the same time celebrated for its wealth."

Having thus settled the question of the desirability of wealth, let us consider what is the engineer's share in its production. The great forces of nature which the engineer utilizes for the production of wealth are the forces of wind and of running water, and the stored energy of fuel in the forests, peat bogs, coal mines and gas and oil wells. By far the greatest of these forms of stored energy is that of coal. Let us compare for a moment the work that can be done by a ton of coal with the muscular power of men. One man digging coal from the side of a hill can easily dig two tons, say 4,000 lbs. of coal, in a day. Another man running a boiler and engine can burn these same two tons under a boiler, and if the engine is a moderately good non-condensing engine using 3 lbs. of coal per indicated horsepower per hour, it will develop from the two tons of coal 133 horse-power for 10 hours, equivalent to the physical labor that could be done by 1,300 men. Thus a man's labor by means of coal and a steam engine can be multiplied 650 times. But if we use a large high-grade triple-expansion, condensing engine, it will require only half as much coal per horse-power, and then if we set the engine to work to mine the coal itself, through the agency of mining machinery, and to feed its own coal to the boiler by means of automatic stokers, we see that the effectiveness of man's labor can be still more vastly increased.

Let us consider some of the results which the engineer has been able to accomplish by the utilization of coal.

In my study of the subject of this address, while I have failed to find it properly treated

in any of the standard works on political economy to which I have had access, I have found it discussed in a more or less fragmentary manner in writings and addresses of numerous engineers, statisticians and other specialists, and since it is more convenient to quote largely from their writings than to write anything original, I will now trouble you with some quotations.

I first quote from a recent lecture by Mr. Edward Orton, State Geologist of Ohio, before the Ohio Mining Institute:

"All the great applications of the stored power of the world belong to the nineteenth century, and the most important of them belong to the last 50 years. What has been done within this century constitutes by far the most important chapter in the economic history of the race. Fossil power lies at the root and center of this unparalleled advance. In Great Britian alone coal does the work of more than 100,000,000 men. It adds to the wealth of these fortunate islands on this basis.

"The great powers, those that are making over the world, are steam and electricity. The steam engine lies at the bottom of by far the greatest industrial and economic revolution through which the race has ever passed, and steam is now being reënforced by the new motor, from which we justly expect so much.

"We note some further consequences of the discovery and use of fossil power on the large scale. We shall find the most striking characteristics of our day and age, so far as the material side of life is concerned, centering around this one element. What are these characteristics of the nineteenth century? There are no more distinctive features of our time than the two following: viz., the remarkable growth of cities throughout the civilized world and the unparalleled increase of the wealth of men. Both take their rise in coal; both are conditioned by its use in all their phases and stages. All modern manufactures are absolutely dependent on the stored force of coal. Machinery driven by this power is everywhere replacing the skilled labor of the olden time. Cities grow largely by massing the ruder labor that our modern factories can utilize.

"With this growth of cities in the modern world, a group of problems arises, all of which are new and of which we are obliged to work out the solutions. No other problems of equal gravity and urgency confront the statesman, philosopher or philanthropist of our day. All of them have their root in coal."

Mr. John Birkinbine, Past President of the American Institute of Mining Engineers, estimates that if only 1% of the consumption of fuel of all kinds in the United States, including coal, wood, oil and gas, were saved, it would be equal to 2,300,000 tons of coal per year. It is the work of the engineer to devise ways and means to accomplish this saving and more.

Mr. Chas. H. Loring, Past President of the American Society of Mechanical Engineers, in his Presidential address in 1892 thus spoke of the influence of the steam engine upon civilization:

"The civilizations of antiquity were limited to a few cities, and were based upon a slave labor, the slaves being drained from other places, which were thus doomed to deepening barbarism.

"The disgrace of the ancient civilization was its utter want of humanity. Justice, benevolence and mercy held but little sway; force, fraud and cruelty supplanted them. Nor could anything better be expected of an organization based upon the worst system of slavery that ever shocked the sensibilities of man. As long as human slavery was the origin and support of civilization, the latter had to be brutal, for the stream could not rise higher than its source. Such a civilization, after a rapid culmination,

had to decay, and history, though vague, shows its lapse into a barbarism as dark as that from which it had emerged.

"Modern civilization also has at its base a toiling slave, but one differing widely from his predecessor of the ancients. He is without nerves and he does not know fatigue. There is no intermission in his work, and he performs in a small compass more than the labor of nations of human slaves. He is not only vastly stronger, but vastly cheaper than they. He works interminably, and he works at everything; from the finest to the coarsest he is equally applicable. He produces all things in such abundance that man, relieved from the greater part of his servile toil, realizes for the first time his title of Lord of Creation. The products of all the great arts of our civilization, the use of cheap and rapid transportation on land and water, and of printing, density of population everywhere, the instruments of peace and war, the acquisition of knowledge of all kinds, are made the possibility and the possession of all by the labor of this obedient slave, which we call Steam Engine.

"We who were born under this benign influence but vaguely appreciate its value, and rarely recognize our obligations to it; existing civilizations would be impossible without it, and if human ingenuity finds no substitute for it they will perish with it.

"The steam engine is a machine which has been the prolific parent of other machines. It has caused the invention and construction of the immense plant of ingenious power tools employed in its own fabrication; it has caused the improvement of metallurgy as a science and of the various methods of metal manufacture as an art; it may be said to have created whole branches of important manufacture, and to have been the occasion of the invention of the immense mass of highly-diversified machinery, by means of which these manufactures are practiced; and, last and greatest, it has stimulated and directed the human intellect as nothing else ever has, and has done more to advance human nature to a higher plane than all which statesmen, generals, monarchs, philosophers, priests and artists have ever accomplished in the vast interval which separates original man from the man of today. It has raised man from an animal to something approaching what a great intelligence should be, by simply placing in his hands a limitless physical power capable of application in every conceivable direction and to every conceivable purpose."

The value of the invention of Bessemer steel to the human race is discussed as follows in an address by Mr. Abram S. Hewitt in 1890 ('Trans. Amer. Inst. Mining Engineers,' Vol. XIX., p. 518):

"The Bessemer invention takes its rank with the great events which have changed the face of society since the Middle Ages. The invention of printing, the construction of the magnetic compass, the discovery of America and the introduction of the steam engine are the only capital events in modern history which belong to the same category as the Bessemer process. They are all examples of the law of progress, which evolves moral and social results from material development. The face of society has been transformed by these discoveries and inventions.

"Steel is now produced at a cost less than that of common iron. This has led to an enormous extension in its use and to a great reduction in the cost of the machinery which carries on the operations of society. The effect has been most marked in three particulars: First, the cost of constructing railways has been so greatly lessened as to permit of their extension into sparsely-inhabited regions, and the consequent occupation of distant territory otherwise beyond the reach of settlement; second, the cost of transportation has been reduced to so low

a point as to bring into the markets of the world crude products which formerly would not bear removal, and were thus excluded from the exchanges of commerce; third, the practical result of these two causes has been to reduce the value of food products throughout the civilized world, and, inasmuch as cheap food is the basis of all industrial development and the necessary condition for the amelioration of humanity, the present generation has witnessed a general rise in the wages of labor, accompanied by a fall in price of the food which it consumes. * * * * These are material results, but they are accompanied with the slow but sure elevation of the great mass of society to a higher plane of intelligence and aspiration."

The increase of working power of the United States is thus shown by Mr. M. G. Mulhall, the great statistician, in the *North American Review* for June, 1895. The working power of an able-bodied male adult is 300 foot-tons daily; that of a horse, 3,000, and of steam horse-power, 4,000. On this basis the working power of the United States was at various dates approximately as follows in millions of foot-tons daily:

Year.	Hand.	Horse.	Steam.	Total.	Foot-tons daily per inh'b'nt.
1820	753	3,300	240	4,293	446
1840	1.406	12,900	3,040	17,346	1,020
1860	2,805	22,200	14,000	39,005	1,240
1880	4,450	36,600	36,340	77,390	1,545
1895	6,400	55,200	67,700	129,400	1,940
Gt. Britain 1895.	3,210	6,100	46,800	56,110	1,470
Germany, 1895.	4,280	11,500	29,800	45,580	902
France, 1895.	3,380	9,600	21,600	34,580	910
Austria, 1895.	3,410	9,900	9,200	22,510	560

Notice from this table how vastly the power of man is increased by the use of the steam engine, and in United States how great was the increase in the last 15 years.

The wealth of the American people, says Mr. Mulhall, surpasses that of any other nation past or present. "The physical and mechanical power which has enabled a community of woodcutters and farmers to become, in less than 100 years, the greatest nation in the world, is the aggregate of the strong arms of men and women, aided by horse-power, machinery and steam power applied to the useful arts and services of of every-day life. The accumulatian of wealth in the United States averages $7,000,000 daily."

The increase of wealth in the United States is shown as follows, according to Mulhall:

Year.	Total wealth, millions of dollars.	Wealth per capita.
1820	1,960	$205
1840	3,910	230
1860	16,160	514
1880	43,642	870
1890	65,037	1,039

Wealth per capita in different countries in 1890;

Great Britian	$1,260
France	1,130
Holland	1,089
United States	1,039
Belgium	840
Germany	730
Sweden	630
Italy	480
Austria	475

Average yearly wages per operative in the United States:

1860	$289
1870	302
1880	347
1890	485

Rural or agricultural wealth in the United States has quadrupled in 40 years, while urban wealth has multiplied sixteen-fold.

	Millions of dollars.			Per cent of total	
	Urban.	Rural.	Total.	Urban.	Rural.
1850	3,169	3,965	7,136	44.4	55.6
1860	8,180	7,980	16,160	50.6	49.4
1870	15,155	8.900	24,055	63.0	37.0
1880	31,538	12,104	43,642	72.2	27.8
1890	49,065	15,982	65,037	75.4	24.6

During the last 20 years the increment of rural wealth has been almost uniform at $47 per head per annum of the number of rural workers. In urban workers the accumulation averaged $83 per annum, which suffices to explain the influx of population into towns and cities.

The increased productiveness of the farmer, due to his use of machinery, is shown as follows:

"An ordinary farm hand in the United States raises as much grain as three in England, four in France, five in Germany and six in Austria, which shows what an enormous waste of labor occurs in Europe because farmers are not possessed of the same mechanical appliances as in the United States.

"In the United States one man can feed 250, whereas in Europe one man feeds only 30 persons. Nor can we hope for a better state of things in Europe soon. So dense is the ignorance of most men, even among the educated classes, that they are convinced that all labor-saving appliances are an evil, and that the more persons there are employed to do any given work the better."

During a visit to Germany three months ago I learned of an instance of this ignorance among the laboring classes. My traveling companion saw three men cutting grass on a lawn with ordinary scythes and sickles. "Why don't you use a lawn mower?" said he, "then one man could do as much as three are now doing." "Don't talk to us about lawn mowers," said one of the men, "it is all we can do now to find work enough to earn our bread. If we had a lawn mower two of us would starve." They did not think that if their employer saved the wages of two men, the money would burn a hole in his pocket until he either employed it for some useful purpose, by giving employment to either the same two men or two others, or loaned it to some one who would employ it.

In the United States, however, the old-time opposition to the introduction of labor saving machinery as a harm to the laboring man, throwing him out of employment, has now almost died out among reasoning men, and it is generally acknowledged by men who have studied the subject that the steam engine and labor-saving machinery in general are the chief agents of the civilization of the latter half of the nineteenth century, and that they have increased the productiveness of man's labor, increased his wages, shortened his hours of labor, cheapened his food and clothing and given the average man comforts and luxuries which a century ago not even kings would have commanded.

Mulhall's 'Dictionary of Statistics' (1892) gives the following facts concerning the agriculture of the world. "Capital and product have more than doubled since 1840, but the number of hands has not risen 50 per cent.

Agricultural Capital of the World Millions of Dollars.

	Land.	Cattle.	Sundries.	Total.
1840	35,475	4,970	4,735	45,180
1860	59,310	7,810	7,495	74,615
1887	88,880	13,505	12,645	115,030

Agricultural Capital in the United States. Millions of Dollars.

	Land.	Cattle.	Sundries.	Total.
1840	2,000	480	500	2,980
1860	6,910	1,130	1,185	9,225
1887	12,800	2,505	3,175	18,480

"In the United States 9,000,000 hands raise nearly half as much grain as 66,000,000 hands in Europe. Thus it appears that for want of implements and of proper machinery there is a waste of labor equal to 48,000,000 of peasants."

The census returns of the manufacturers of the United States, 1880 and 1890, show the following:

	1880.	1890.	Increase per cent.
No. of establishments reporting	253,502	322,624	27.27
Capital	\$2,780,766,895	\$6,138,716,604	120.76
Av. No. of employees	2,700,732	4,476,094	65.74
Total wages	\$939,462,252	\$2,171,356,919	130.13
Cost of materials used	3,395,925,123	5,018,277,603	47.77
Value of products	5,349,191,458	9,054,191,458	69.27

Vast economic changes throughout the world have recently taken place as the result of the development of engineering. Mr. Edgerton R. Williams in his article on 'Thirty Years in the Grain Trade' (*North American Review*, July, 1895), says:

"In 1869 97% of England's population, say, $18\frac{1}{2}$ out of 19 millions, were fed on English-grown wheat. In 1890, with a population of 25 millions, only 5 millions were supplied with English wheat, a falling-off of 77%. The decrease in wheat average in 40 years, from 1846 to 1886, was nearly 66%."

The tendency of population from the country to the cities is a consequence of the increased production of manufactures and of the decrease in the percentage of the total population required to produce the food of the world. This tendency in the United States is shown in the following census figures:

Urban population, per cent. of total.

United States	1850	1860	1870	1880	1890
Per cent	12.49	16.13	20.93	22.57	29.12

In the northern central division of the United States, in the past ten years, the urban element has nearly doubled, while the total population has increased only 25.78%. The increase in urban population is confined mainly to a few large cities.

The completion of the Trans-Siberian Railroad, and the extension of railroads in India and in the Argentine Republic will probably before long make Europe independent of the grain crop of America. Mr. Worthington C. Ford, Chief of the United States Bureau of Statistics, in the *North American Review* for August, says: "It is now the Argentine Republic which appears to have an almost unlimited power to grow and export wheat in defiance of any competition." The perfection of refrigerating machines—an engineering triumph—makes it now possible for Europe to receive its supply of meat from Australia and from the Argentine Republic, as well as from the United States. The introduction of modern cotton machinery into Japan and into India threatens the cotton trade of England with exclusion from the markets of Asia, one of England's greatest present resources. In Australia, according to Mr. Ford, the ranchmen are successfully overcoming one of the most serious obstacles to the extension of sheep raising, by sinking artesian wells and making pools or dams to retain the water for their stock—another example of the application of engineering in using nature's stored forces to overcome the resistance of nature. There thus appears to be no limit to the economic changes throughout the world which may yet be made by the use of engineering appliances.

Marked economic effects have attended the building, or failing to build, important highways in the United States of whatever kind where opportunity and need existed. The early topographical engineers of the country, including especially George Washington, who was an engineer by profession, foresaw that at whatever point on the Atlantic coast an outlet should be made for the products of the Ohio and Mississippi valleys, a great, probably the greatest, seaport would arise. Virginia was at this time far in advance of the other States, and especially of New York. * * * Washington urged the Legislature of Virginia to build a canal connecting the Ohio River and the James or Potomac, so as to place the outlet at Norfolk. His advice was not heeded. Subsequently New York, under the leadership of De Witt Clinton, constructed the Erie Canal, connecting Lake Erie, at Buffalo, with the Hudson, at Albany, then a stupendous feat of State enterprise in finance and civil engineering. Until that canal was built New York city had little more than the trade of the Hudson River valley. The building of the canal made New York the Empire State, and the city the commercial metropolis of the Union—Denslow, p. 150.

Who can estimate the economic value to the United States of that great feat of engineering, the building of the first railroad across the continent? What an increase of the wealth of nations has flowed from the opening of the Suez Canal, and what another

increase will follow the completion of the Nicaragua Canal!

Improvements in engineering methods often cause the destruction of vast amounts of fixed capital by the substitution of new appliances for the old. The British government expended in 1864–'70 £20,000,000 on a class of armored gunboats, which, before any use was made of them, were condemned as worthless, owing to the improvements in the construction of guns. It expended large sums on iron guns, which became useless by the substitution of steel guns, etc.

A telegraph company expended large sums of money in constructing a line through Siberia and Alaska, whereby to get telegraphic communication between New York and London via San Francisco and Behring Straits, which was made totally worthless by the laying of the first Atlantic Cable (Denslow, p. 81). Numerous canals and canal boats have been thrown out of use and allowed to fall into decay on account of the competition of railroads.

Between 1872 and 1880 a revolution took place in the construction and in the method of driving blast furnaces for making iron, so that of 700 blast furnaces running or in condition to run in 1872, probably not 50 are now on the active list, and although the production of iron has more than quadrupled since that date, only 480 furnaces are now on the list of existing furnaces, and more than half of these are out of blast. The destruction of capital involved in the abandonment of old furnaces is probably over $100,000,000. A similar destruction of fixed capital has followed the substitution of Bessemer steel for puddled iron, and the introduction of improved forms of rolling mills. A great decrease in the value of the iron mines of New Jersey, New York and Pennsylvania has followed the opening of better mines in Lake Superior.

One of the great achievements of engineering is the substitution of the factory system of labor for the old domestic system. The beginning of the factory system was in the decade of 1760–1770, when the spinning jenny, the spinning frame and the spinning mule were introduced into the textile industry, but it did not begin its full career of development until after Watt had perfected his steam engine about thirty years later. Has the factory system been a benefit to civilization? There is no better authority on this question than Mr. Carroll D. Wright, formerly United States Commissioner of Labor, and now Commissioner of the Census of 1890. He says: (Johnson's Cyclopædia, Vol. III., p. 265): "The factory system is in every respect vastly superior to the domestic system as an element of civilization, although this is contrary to popular impression and largely against popular sentiment. * * * Under the domestic system the home of the worker was the workshop also, and the wheels or looms disputed with the inmates for the room and the conveniences for house work. Small, close crowded, with bad air and bad surroundings, the hut of the domestic worker was occupied by a class which had not found, and cannot find, its like under the factory system, for, as a rule, the operative of to-day occupies a home even in the factory tenement or boarding house superior in every sense to the home of the domestic worker.

"Under the domestic system of industry grew up that great pauper class in Great Britain which was a disgrace to civilization. It continued to grow, until one-fourth of the annual budget was for the support of paupers. * * * The domestic labor's home was far from having the character poetry has given it. Huddled together in what poetry calls a cottage and history a hut, the weaver's family lived and worked without comfort, conveniences, good food, good air, and without much intelligence. Drunken-

ness and theft of materials made many a house the scene of crime and want and disorder. Superstition ruled, and envy swayed the workers. Ignorance under the old system added to the squalor of the homes of the workers under it, even making the hut an actual den, shared in too many instances by the swine of the family. The home of the agricultural laborer was not much better; in fact, in Great Britain and France he has to a great degree continued in his ignorance and in his degraded condition.

"One of the positive results of the factory system has been to enable men to secure a livelihood in fewer hours than of old. This means intellectual advancement, for, as the time required to earn a living grows shorter, civilization progresses. * * * The fact that the lowest grade of operative can now be employed in factories does not signify more ignorance, but a raising of the lowest to higher employments. This process is constantly narrowing the limits of the class which occupies the lowest step in the progress of society. This mission alone stamps the system as an active element in the moral elevation of the race. The factory system does not tend to intellectual degeneracy."

The arguments thus far adduced have all been one-sided in showing that an increase in civilization and in refinement follows an increase in wealth. There is another side to the question. A portion of the laboring masses are dissatisfied. This side is ably treated in this month's issue of the *North American Review*, by Rev. J. S. Zahm, C. S. C., entitled 'Leo XIII. and the Social Question.' I quote as follows:

"In lieu of the old organic regime the French Revolution substituted the reign of individualism. Unlimited competition, freedom of labor, the preponderance of capital and the general introduction of machinery ushered into existence the fourth estate proletarians, or wage-earners—and with it the social question. The organism became a mechanism, and from its excesses proceeded the evils from which we now suffer. As matters at present stand, we have two inimical forces, standing face to face; on one side, the modern state, with its army and its police; on the other, socialism and organized labor with its battalions and its long pent-up grievances.

"Never before was humanity confronted with such a danger. Three centuries of renaissance of pagan law and a century of *laissez-faire* and *laissez-passer* have atomized society and divided the human family into two opposing camps—on one side the tyranny of the law and of the employer; on the other, renewed servitude and virtual rebellion—everywhere hatred, lack of equilibrium, egotism and overt struggle.

"Formerly after the struggle between employer and employee was over, rest and peace were to be found in the workshop or in the home, whereas to-day the struggle has reached our very hearthstones. It persists in a dull and sullen manner, when it does not break forth openly, and it is ever compassing the ruin of society because it is incessantly destroying all chance of domestic happiness. Never before, indeed, has the social question knocked in so threatening a manner at the doors of the civil order."

Mr. Zahm charges machinery, which is engineering, with being one of the chief causes of social troubles. He says further:

"It may truly be said that the social question arises from a five-fold revolution: the revolution in machinery; the revolution in political economy; the revolution in religion; the revolution in the state, and the revolution brought about by the general movement of humanity.

"Machinery, or rather the abuse of machinery, was the first to effect a transformation in the economic order. It is not without reason that Lasalle styles it 'the revolution incarnate'—*Die verkoerperte Revo-*

lution. Machinery has revolutionized the mode of production, the manner of labor, and the distribution of revenue and of property. It has destroyed the workshop and introduced the factory in its stead. It has sterilized manual labor, and, by its immense productivity, has internationalized prices and markets. While, on the one hand, it has created the despotism of capital, it has, on the other, called into existence the unorganized army of the proletariate. It has ground humanity into a powder, without cohesion and without unity, and has placed the world of labor at the mercy of a few soulless plutocrats. This new order of things means the reign of the few; it implies the permanence of expropriation and the resurrection of ancient Rome, where millions of slaves were trampled under foot by an insolent oligarchy of wealth. And finally, by its fatal centralization machinery has engendered a double International—the International of capital and the International of socialism. Never has a more complicated situation, or one more pregnant with peril, weighed upon men. What were the invasions of the barbarians from the north of Europe, or the upheavals of the fifteenth and eighteenth centuries, in comparison with the threatened explosion of this vast world already stirred to its profoundest depths and in a state of violent ebullition?"

The remedy for this terrible state of affairs, according to Mr. Zahm, is to be found in following the advice given in the recent encyclical letter of the Pope. I quote.

"In the introduction to his epoch-making document, Leo XIII. directs attention to some of the evidences of the dominant evil, extreme riches, extreme misery, and the indescribable desolation which has entered the world of the proletariate in consequence of the atomization of society under the leveling reign of capital.

"As in the politico-religious order, Leo XIII. has, through his encyclical '*Immortale Dei*,' preached the code of reconciliation, so has he, in the economic order, promulgated the character of social harmony. For the first time economic science has pity on the wage-earner, and discusses the new issues raised without rancor or recrimination. At the same time it exhibits a respect for the rights of all while insisting on the duties of all, which will forever render the encyclical, '*Rerum Novarum*,' not only the most glorious monument of the present pontificate, but also the most beneficent contribution yet made to the new order of things."

We must give all honor to Pope Leo XIII. for his earnest efforts to bring about social harmony, but Mr. Zahm is surely not right in saying that this is the first time that economic science has pity for the wage-earner. Many writers in all schools—Henry George, for example—have been animated by sincere sympathy for the wage-earner, and have earnestly discussed means of ameliorating his condition. I hope to show in my conclusion that the whole tendency of economic evolution is toward bettering the condition of the wage-earner.

Mr. Hewitt in his Presidential address before the American Institute of Mining Engineers in 1890, entitled 'Iron and Labor,' 'Trans. A. I. M. E.' Vol. XIX., pp. 496, 497, speaks of 'the new era,' when every intelligent workman will insist on being an owner, and every well-managed corporation will see that its workmen are directly interested in the results of the business. He says: "The time is approaching when capitalists and laborers will more and more be joint owners in the instruments of production. While the wages system will necessarily survive, the workmen will, to a large extent, become their own employers, and finally may hire capital as capital now hires labor. The facilities offered for the division of prop-

erty, through the distribution of corporate shares, will lessen strife, develop skill, reduce cost, increase production and promote the equitable distribution of wealth, which, it must never be forgotten, is the chief end of the social organization."

The equitable distribution of wealth which Mr. Hewitt speaks of is the aim of all honest political economists of all schools. They only differ as to the means through which it is to be brought about, and they differ vastly in their apprehension of what is the existing state of things. The chief difficulty of the socialist writers and such men as Henry George and Mr. Zahm is that they do not see clearly the existing facts. Seeing the vast wealth of a few individuals, they preach the dictum the 'rich are growing richer and the poor are growing poorer,' the last half of which is a stupendous economic falsehood, equalled only by the dictum of the anarchists that 'property is robbery.' Innumerable facts can be adduced to show that the statement that the poor are growing poorer is a falsehood. Statistics prove beyond all question that in all the civilized world the wages of labor have tended, ever since the extensive use of the steam engine, say, since 1850, to increase, and the cost of living to decrease. Statistics of savings banks, of building associations, of life insurance companies, of fraternal assessment life insurance associations, of the ownership of small houses and small farms, of the reduction of mortgages on farms, all show that not only is there a vast increase in the wealth of the Nation as a whole, but that this wealth is being more widely distributed than ever before. A magazine article recently said that more than one-half of the entire population of New England, including men, women and children, are depositors in the savings banks, the average amount to the credit of a depositor being $363. It says of the depositors: "If it were possible to prove what is apparent to the eye of any one who watches the customers of these banks, it would be found that very much the largest part of them are the women and children. The aggregate deposits in the savings banks in New England is $774,000,000. In New York State alone it is $644,000,000.". In the little town in which I live, Passaic, N. J., containing 18,000 inhabitants, a considerable part of the popnlation are Poles, Bohemians, Hungarians and other natives of southern Europe. They are recent immigrants, working in mills; yet one of the two savings banks in the city has 2,500 depositors, the deposits amounting to nearly $400,000; and in addition these same foreigners last year sent to Europe, in the shape of drafts issued by this same bank, not less than $50,000.

Place the statements just made concerning savings banks against those made by Mr. Zahm—viz., that the human family is divided into two opposing camps; that we have two inimical forces standing face to face: on one side the modern State with its army and its police; on the other socialism and organized labor. How can we reconcile these two apparently conflicting views of the existing status? Why, very easily. Mr. Zahm's two opposing camps exist: on one side the socialists, on the other side the police; but his eyes were blinded when he said that the whole human family is divided into two opposing camps. He failed to see the vast majority of the people who belong to neither one camp nor the other, who are the savings bank depositors, the owners of small homes, albeit with small mortgages on them, who are members of building associations and fraternal life insurance societies. The grandest fact in the economic history of this age is the great increase in the number of the people in comfortable circumstances who once were numbered among the poor. The increase in the middle class goes along with a great decrease in the

number of the very poor. The poor are growing poorer, say the agitators. Whom do you mean by the poor? Is it a family that has only $100 in the savings banks? Next year it will have $200 and five years thence $1,000.

Do you mean, then, we ask the agitator, the man who has not a dollar in any bank, who has not enough ahead to keep him from starvation a week? If he is the man whom you call poor, and whom you have been saying for the last 20 years that he is growing poorer, how much poorer is he going to get? How many such men are there in the United States? Let them stand up and be counted.

We have seen that engineering is the chief factor in the production of wealth; that wealth has enormously increased in the past few years, and that it is being well distributed, although perhaps not as well as it ought to be, among the common people. What of the future? Engineering has caused men to leave the farm and seek the cities, because in the cities they can grow rich faster. Engineering, again, through rapid transit, electric cars and the like, is making it possible for these men who work in the city to sleep in the suburbs, and bring up their families in a place which has all the advantages of city and country combined. One of the triumphs of the iron-making engineer has been the construction of a hollow steel tube of great lightness and strength. The mechanical engineer has found out how to make ball bearings, and lo! we have the bicycle of 1895, 400,000 of them to be made in this year. Who can estimate the value to the people of this new industry, building up an athletic and healthy race of men and women, and causing good roads to be built from one end of the country to the other, another work of engineering by which the farmer may move his crops more cheaply and the cost of food be correspondingly decreased. What next? As Mr. Hewitt has foreseen, the wage-earner will become a stockholder in the corporations for which he works, and labor will hire capital, instead of capital hiring labor. Then what Mr. Zahm calls the fourth estate, the proletariat, will cease to exist. It will be merged into the third estate, the common people, who are at the same time wage-earners and capitalists. The proletariat, or fourth estate, as a separate element in society, antagonistic to the third estate, is already a vanishing quantity. We who are old enough remember the alarm created throughout the world in the years 1867, 1868 and 1869 when the dreaded 'International' held its congresses in Europe. Who now dreads the International. True, it may be strong enough some day in some one or more places to repeat the terror of the Paris Commune in 1871, but the uprising will end as the uprising of the Commune did, and it will not take two months to end it, as it then did.

"The Empire is peace," said Napoleon III. just before the Franco-Prussian War. He was mistaken. The war took place, causing vast loss and suffering, followed by the terrible agony of the Commune. But how nobly France recovered from the shock, how quickly she paid the indemnity to Germany out of the actual stored savings of her common people. No revolution in the social order took place, only a change in government, then everything went on as before. So it will be if the International should arise, as is predicted by the alarmists, and reproduce the horrors of the French Revolution. The world will live through it; the social order, as of old, will be restored, and the present relations of capital and labor will not be changed, except as by gradual and necessary evolution, due to engineering more largely than to any other one cause, capital and labor becoming merged by the laborers becoming capitalists. This will be the crowning triumph of engineering,

through which the increase of wealth is caused, which enables the laborer to become a capitalist. Then the political economists may meet together and discuss the improved social order, burn their old books, and erect a monument to the man who above all others contributed the means for obtaining the wealth of nations, James Watt, the engineer. WILLIAM KENT.

JOHN ADAM RYDER.*

In 1875, exactly one score of years ago, John A. Ryder began his work at the Academy. Six of these years were spent in the service of the government. The remaining fourteen were in close communion with these halls. The museum and library were the scenes of his many labors.

At one time his friends feared that he was covering too large a field. Doubtless, the fear would have been sustained if Ryder had pursued his studies along conventional lines. But we must not judge him by such a standard. His mental attitude was well poised. The objects that 'swam into his ken' came from a wide space. So long as he was searching for the results of vital forces on the economy, it mattered little to him whether it was the teeth of mammals, the tails or scales of fishes, or the movements of protoplasm in a rhizopod that illustrated these actions.

While arranging the collections of the Academy as a Jessup Fund student he found material for his studies in teeth of quadrupeds; while on excursions in the city park, in the smaller articulated animals feeding on fungi or swimming in pools; while on the Fish Commission, in the oyster and its parasites and the movements of fishes; as professor of histology and embryology at the University, in the preparation of specimens for courses of instruction.

What were the mental forces that operated in Ryder to make him what he was? This is of interest, for the result of comparative studies is to aid us in knowing ourselves. How strange is the phenomenon! First, a young student coming to the Academy so absolutely unknown that his first application to a position on the Jessup Fund was deferred. Second, his obtaining the position and setting to work on the collection, rearranging and cleansing specimens, refilling jars and cataloguing. Third, after a career of four years attracting the attention of Professor Baird and leaving the city to accept an appointment on the Fish Commission. Fourth, returning to Philadelphia in 1887 and again in frequenting the Academy, no longer working on its collections, but consulting its library and speaking at its meetings as a University professor. So we find Ryder at the beginning and at the end of his career part of the Academy. But where, in this chain of circumstances, do we find the factors which gave to Ryder those things which distinguish him? Almost precisely the same conditions (so far as the Academy and the University were concerned) were met with in Leidy. Yet how different were the two men! Indeed, so little did Leidy understand Ryder that he endeavored (with the most kindly motive) to dissuade him him from a career of study. Leidy knew that men who are dependent on science for a livelihood secure fewer prizes in the struggle for maintenace than do those in any other learned calling. This statement is yet true, and it had special force twenty years ago.

Thus while the Academy gave Ryder incalculable aid (the soil, indeed, in which he grew), the influences which determined the character of his work were extraneous. These were in brief the influences of the

*An address on 'Dr. Ryder's relations to the Academy of Natural Sciences;' of Philadelphia, by Dr. Harrison Allen, given at the memorial meeting on April 10, 1895, and published by the committee in charge of publication.

theory of evolution as applied to living things, which brightening the horizon of science relieved it of all mists, such as the theories of Oken and its many variants, before men of Ryder's age looked toward the dawn for inspiration.

In America, to use Professor Packard's expression, a neo-Lamarckian phase of the theory of evolution arose. It held to an insistence of mechanical causes in modifying the shapes of organisms. Its advocates were Alpheus Hyatt and Edward D. Cope, men whom Darwin did not understand, but Ryder did; and, while he is in no respect a disciple of either of these distinguished men, his career was in a sense determined by them.

The forces which Ryder so eagerly studied were those which tended, as he believed they did, to modify endlessly the bodies in which they are exercised. The living body is compared by him to a machine in motion, which changes the shape of the machine itself by virtue of the motions; he believed that such changes are transmitted to offspring, and in this way organisms tend to endless variation. Nothing is fixed but the initial necessity to change.

Dr. Ryder might have done well had he confined himself more than he did to the study of species and genera. His papers in this line were excellent. He announced several forms of Thysanura, Myriapods, fresh water crustaceans, and a new fresh water polyp. He revised the account of the sturgeons of our eastern waters, and resusciated Le Sueur's *Accipenser brevirostris*, an old specimen of which (probably part of the material on which the species was named) was found by Ryder in the Museum of the Academy.

In competent hands the elucidation of species is not, as it has opprobriously been said to be, a dullard's task of taking an inventory of nature, but the study of the ultimate forms which those organisms assume which breed true. The shifting of color-schemes, the exhibition of the effects of retardation or precocity in the development of the individual, the effects of food and climate on size in whole or in parts, and of other causes by which minute differentiations are started and maintained, are of unending interest, and worthy of the best powers of the naturalist. If Ryder had been more closely identified than he was with the careers of the great academicians who had preceded him he would in no whit have detracted from the value of his philosophical labors. One cannot but regret, if for no other reason than for his health's sake, that he discontinued those fruitful excursions to our woods, ponds and rivers by which he contributed so notably to our micro-fauna.

With nameless regret, we note in what degree his exceptional powers were wasted. We see him in training as an oyster culturist, or busy with details of affairs on the Fish Commission. We see him giving his substance of energy to undergraduate instruction. Why do we insist that penknives are appropriate tools to fell oaks? that pedagogy is a suitable career for a man who has rare gifts for investigation? We may never see nor the world see the like of Ryder again. Why did we not get all that was possible from him while he was here, and leave the tasks of teaching undergraduates to those equally earnest with himself, to teachers as capable as himself, but who did not possess a tithe of his ability as an inquirer after truth? Teaching, it is true, gave him his maintenance, one which he preferred to any other. Alas! that there is no larger Jessup Fund for matured students as well as tyros! No complaint is here made that as compared with other students Ryder had not received due consideration. Nevertheless, bureau employment and teaching are not the best uses to which we can put exceptionally en-

dowed men. Ryder was patient and dignified. He was not a Pegasus chafing in his harness, but as one consecrated to the calling of his choice and on whose heart the lowliest duties on itself did lay. But we are the losers. We cannot but be saddened at the knowledge that he did not live to put in form and substance the results of his profound labors. His work is like an unfinished house webbed in scaffolding, with heaps of building material scattered about the ground. The spirits to which Ryder was kin (the Keats, the Mozarts), visit us at long intervals, and when they come we treat them as though they were ordinary mortals after all.

HARRISON ALLEN.

REPORTS OF INTERNATIONAL METEOROLOGICAL MEETINGS.

Two of these have lately been received; the first being the Report of the International Meteorological Congress, held at Chicago in August, 1893. This Congress was remarkable for the number of papers presented rather than for the number of persons who assembled to hear them read, and yet it seemed doubtful whether they could be published, as the Congress Auxiliary of the Columbian Exposition had no funds available. Fortunately, the U. S. Weather Bureau was able to accomplish this in its series of Bulletins, Bulletin 11, Part II., now before us, forming Part II. of the Report, which is devoted to history and bibliography, agricultural meteorology, atmospheric electricity and terrestrial magnetism. The first section is of special interest, as it contains a detailed account of the commencement and development of meteorology in the United States, with which the Army Medical Department, the Smithsonian Institution, the Hydrographic Office and the Signal Service were chiefly concerned. Two papers of much bibliographical interest, relating to English meteorological literature from 1337 to 1699 and to meteorology and terrestrial magnetism in the fifteenth, sixteeenth and seventeenth centuries, were contributed, respectively, by Mr. Symons, of London, and Dr. Hellmann, of Berlin, the two highest authorities on this subject. This Report is edited by Mr. O. L. Fassig, the able librarian of the Weather Bureau, who deserves great praise for effecting translations of the various foreign papers, with no pecuniary assistance, and otherwise performing a difficult task in so satisfactory a manner. Part I., which appeared more than a year ago, contained the papers on weather services and methods, rivers and floods and marine meteorology; while Part III. will comprise climatology, instruments and methods of observation and theoretical meteorology.

The second report to be mentioned is that of the International Meteorological Committee, chosen at the Munich Conference in 1891, which held its first meeting at Upsala in August, 1894. The proceedings are published in three languages, and the English edition, prepared by Mr. R. H. Scott, Secretary to the Committee, is issued as No. 115 of the official publications of the London Meteorological Office. The present members of the Committee and the countries which they represent are as follows: Messrs. von Bezold (Prussia), Billwiller (Switzerland), de Brito-Capello (Portugal), Davis (Argentine Republic), Eliot (India), Ellery (Victoria, Australia), Hann (Austria), Harrington (United States), Hepites (Roumania), Hildebrandsson (Sweden), Mascart (France), Mohn (Norway), Paulsen (Denmark), Scott (Great Britain), Snellen (Holland), Tacchini (Italy) and Wild (Russia). Among the most important resolutions was that the proposed International Meteorological Bureau was not realizable, but that the Committee appeared to be the proper body to establish and maintain relations between the

different institutions and to arrange for the carrying-out of investigations of general utility. It was decided that a conference, similar to that of Munich, should be held in Paris in September, 1896. The Cloud Committee, consisting of Messrs. Hann, Hildebrandsson, Mohn, Riggenbach, Rotch and Teisserenc de Bort reported upon the proposed cloud atlas, its cloud definitions and the instructions for observing them. It was recommended that measurements of the altitude of clouds (preferably by photographic methods) at a limited number of stations, and direct observation of the velocity of motion of clouds at a larger number of stations throughout the world, be commenced May 1, 1896, and continued one year.

A. LAWRENCE ROTCH.

THE AMERICAN CHEMICAL SOCIETY.

THE *American Chemical Society* held its eleventh general meeting at Springfield, Mass., August 27th and 28th. The address of welcome was delivered by Mayor Charles L. Long, and the response to the same was made by the President of the Society, Professor Edgar F. Smith. No business was transacted, the entire time of the three sessions being wholly devoted to the reading of the following papers and to their discussion :

1. 'Determination of the Heating Effect of Coal,' W. A. Noyes, J. R. McTaggart and H. W. Craven. 2. 'Use of Aluminum for Condensers,' T. H. Norton. 3. 'A Case of Mistaken Identity' (relating to the tetrachloride of zirconium), F. P. Venable. 4. 'The Determination of Sulphur in Refined Copper,' George L. Heath. 5. 'The Possibility of the Occurrence of Hydrogen and Methane in the Atmosphere,' Francis C. Phillips. 6. 'The Evolution Method for the Determination of Sulphur in Iron,' Francis C. Phillips. 7. 'Metaphosphinic Acids and their Derivatives,' Henry N. Stokes. 8. 'The Analysis of Alloys Containing Tin, Lead and Antimony,' Launcelot Andrews. 9. 'Observations on Double Platinum Salts,' Charles N. Herty. 10. 'A New Electrical Process in Making White-lead,' R. P. Williams. 11. 'Estimation of the Extraction in Sugar Houses' (by title), M. Trubeck. 12. 'Tellurium, its Separation from Copper Residues with Notes on some New Reactions,' Cabell Whitehead. 13. 'Arsenic in Glycerol,' George E. Barton. 14. 'The Occurrence of Trimethylene Glycoll as a Bi-Product in the Glycerine Manufacture,' Arthur A. Noyes. 15. 'The Electrolytic Reduction of Paranitro Compounds in Sulphuric Acid Solution,' Arthur A. Noyes. 16. 'Speed of Oxidation by Chloric Acid,' Robert B. Warder and Herman Schlundt. 17. 'Acidimetric Estimation of Vegetable Alkaloids,' Lyman F. Kebler. 18. 'A Study of Some of the Gas-producing Bacteria' (by title), A. A. Bennett. 19. 'Picrates' (by title), George B. Pfeiffer. 20. 'A New Burette Holder,' W. K. Robbins. 21. 'A New Form of Water Bath,' W. P. Mason. 22. 'The Reaction Between Concentrated Sulphuric Acid and Copper,' Charles Baskerville.

After all the papers had been read President Edward Morley, of the American Association, who was present, was called upon for remarks, and he summed up the results that have been secured by the various workers who have labored to determine with accuracy the atomic weight of oxygen, giving as the final probable average of the results 15.879. These remarks were of especial interest, as Prof. Morley himself has done more than any other investigator to determine the atomic weight of oxygen, spending years upon the subject and making a number of elaborate and careful determinations. President Smith, of the Society, then gave a warm tribute to the work done by Prof. Morley and congratulated the chemists of this country on having among their number one whose work ranks with the highest done by any investigator in the world.

The Society visited the works of the Holyoke Paper Company, of the Merrick Thread Company, the plant of the Farr Alpaca Company, the Hampton Paint and Chemical Company and the U. S. Arsenal.

The present membership of the Society is 950. Eight active sections now exist in various parts of the United States, with

the possibility of two more before the year closes.

The mid-winter meeting will be held at Cleveland, Ohio.

SCIENTIFIC NOTES AND NEWS.

RAILWAY SPEED IN GREAT BRITAIN.

MR. CHARLES ROUS-MARTIN, an English authority on railway working, published a paper in the London *Engineer* of August 9th, in which he discusses what has come to be called 'the railway race to Aberdeen,' between the East and the West Coast routes. It began July 1st by the reductions of the schedule time from 11 h. 35 m. and 11 h. 50 m. to 11 h. 40 m. by the West Coast line. East Coast, then, came to 11 h. 20 m.; then West Coast to 11 hours. Next East Coast made the 523 miles in 10 h. 45 m., July 22 and, the same day, West Coast 543 miles in 10 h. 45 m. The last figures to date were 10 h. 25 m. and 10 h. 20 m. The running speed ranges between 60 and 75 miles an hour, which figures have been repeatedly bettered, previously, for short distances, by local trains. The higher the speed, the steadier was the motion of the train. The present writer came up from Perth to Edinboro' on such trains and can report extraordinarily easy and smooth motion of engine and carriages at speeds estimated to be much above seventy miles for considerable distances. It is concluded that the American system of 'bogie' or 'truck' is much better than the old English six-wheeled rigid type of carriage. The East Coast line employed single drivers 7 ft. 7 in. to 8 ft. 1 in. diameter and the West Coast two pairs coupled of 6 ft. 6 in. diameter. Speeds of 80 miles were sometimes touched; but rarely were the velocities considered extraordinary. The engines were in some cases simple, sometimes compound. All did magnificent work. The loads were 180 to 200 tons. R. H. T.

ROYAL SOCIETY OF NEW SOUTH WALES.

THE Society offers its Medal and £25 for the best communication (provided it be of sufficient merit) containing the results of original research or observation upon each of the following subjects:

Series XV.—To be sent in not later than 1st May, 1896. On the origin of Multiple Hydatids in man. On the Occurrence of Precious Stones in New South Wales with a description of the Deposits in which they are found. On the effect of the Australian Climate on the Physical Development of the Australian-born Population.

Series XVI.—To be sent in not later than 1st May, 1897. On the Embryology and Development of the Echidna or Platypus. The Chemical Composition of the Products from the so-called Kerosene Shale of New South Wales. On the Mode of Occurrence, Chemical Composition, and Origin of Artesian Water in New South Wales.

The competition is in no way confined to members of the Society, nor to residents in Australia, but is open to all without any restrictions whatever, excepting to members of Council for the time being. The communication to be successful must be either wholly or in part the result of origin observation or research on the part of the contributor. The Society is fully sensible that the money value of the Prize will not repay an investigator for the expenditure of his time and labor, but it is hoped that the honour will be regarded as a sufficient inducement and reward. The successful papers will be published in the Society's Annual Volume. Fifty reprint copies will be furnished to the author free of expense. Competitors are requested to write upon foolscap paper—on one side only. A motto must be used instead of the writer's name, and each paper must be accompanied by a sealed envelope bearing the motto outside, and containing the writer's name and address inside.

All communications are to be addressed to the Honorary Secretaries, T. W. E. David and J. H. Maiden, The Society's House, 5 Elizabeth Street, Sydney.

GENERAL.

THE Kansas University Geological Expedition has returned from the field with large and valuable collections of Mesozoic and Tertiary vertebrate fossils, aggregating nearly five tons in weight. Among the material are two complete skeletons of *Bos antiquus*, which will be mounted in the museum; an excellent skull of *Monoclonius* (*Triceratops*) and a specimen of *Hesperornis*, which is unequalled in any collection for perfection and completeness, and is of especial interest from the fact that the chalk slab upon which it is lying shows clear impressions of the dermal covering.

A FEDERAL DECREE published in the 'Diario Oficial,' on the 25th June, established the metric system of weights and measures obligatory in the United States of Mexico, on and after September 16, 1896. The metric system has been in use in the government departments of Mexico for some time past; the decree makes it the sole legal system throughout the Republic and will do away with the heterogeneous old Spanish measures hitherto tolerated in ordinary business transactions.

AFTER one of the sessions of the Section of Mechanical Science and Engineering of the A. A. A. S. the members were invited to inspect the Duryea motor wagon, and saw the carriage in successful operation. Some of the members rode in it and were delighted with the ease with which the carriage could be managed and the way in which it performed its work. The Messrs. Duryea began their study of this subject in 1886, began construction in 1891, and the present carriage was completed last March. Further improvements have been made which will be embodied in the next one constructed. The tires are pneumatic and the general appearance of the carriage is very nearly like the ordinary piano-box type.

ON the occasion of the visit of members of the A. A. A. S. to Amherst, Professor Emerson exhibited the important paleontological, geological and mineralogical collections belonging to the College. Professor Emerson's laboratory and lecture-room was, from a pedagogical point of view, of much interest. One of the appliances was a blackboard constructed on what seems to be a new principle. The face was of ground glass in a hinged frame with a black surface back of the glass. This makes a good blackboard in itself, but its special advantage is that diagrams can be inserted back of the glass, and the drawing can be continued in the presence of the students.

Nature states that a civil list pension of £200 has been granted to Mrs. Huxley.

The Educational Review for September contains three of the principal evening addresses given before the Denver meeting of the National Educational Association:—the Presidential address, by Prof. N. M. Butler, on 'What Knowledge is of Most Worth,' an address by Prof. Joseph Le Conte, on 'Evolution and Education,' and an address by Prof. W. H. Payne, on 'Education According to Nature.' *The Review* also contains the reports of two committees presented to the National Council of Education:—one on the 'Laws of Mental Congruence and Energy applied to some Pedagogical Problems' and one on 'The Rural School Problem.'

THE daily papers contain a telegram from St. John stating that news of the Peary Relief Expedition has been received from the American schooner John E. Mackenzie, returning from the Greenland halibut fishery. The Mackenzie met the Kite with the expedition at Holsteinburg on July 15. At

Holsteinburg the Kite took aboard Professor Dyche, one of the members of the expedition, and sailed again that same evening. Very little ice was reported south of Greenland waters. The crew of the Mackenzie think the Kite will have no difficulty in reaching Whale sound, where Peary's headquarters are located. The return of the relief party is expected about the end of this month.

THE conditions attached to the bequest of $60,000 made by the late Sir William Macleay to the Sydney University to found a chair of bacteriology are such that the University has decided to decline the bequest. The money will now revert to the Linnæan Society to maintain a bacteriologist who will carry on bacteriological investigations and also take pupils.

M. C. H. FRÉMONT described before a recent meeting of the Paris Academy of Sciences a special microscope for the observation of opaque bodies. A concave mirror is placed within the tube of the microscope which reflects a ray of light through the lenses of the objective to the object.

AMONG recent appointments abroad, Professor Strahl, of Marburg, has been called to the chair of anatomy in the University of Giesen; Professor Hans Lenk, of Leipsig, to the professorship of geology in the University of Erlangen; Dr. Haecker, of Freiburg i. B., and Dr. v. Dalla-Torre, of the University of Innsbruck, have been made assistant professors of zoölogy.

ON August 15th, Dr. Münch, the physicist, died at the age of 75 years. The deaths are also announced of M. H. Wittmeur, professor of minerology and geology in the University of Brussels, and of Dr. W. Fabritius, astronomer in the Observatory of Kiew.

La Nature states that an Ethnographical Exposition has been opened at Paris on the Champ-de-Mars by MM. Barbier, exhibiting a negro village of western Africa; not only the inhabitants, but also the manners and customs of the people are represented. The negro families occupy houses grouped according to their race, the architecture being a faithful imitation of the originals. Even native animals and plants have been introduced.

PROF. H. H. POWERS, now of Smith College, has been called to the professorship of economics at Stanford University.

IT is stated that Professor Carl Barus has constructed a new top for educational purposes. The 'peg' of the top consists of a writing stylus, adapted to pencil a graphic record of its motions upon a slate or sheet of paper. This motion of the 'peg' simulates the motion of precession about a movable axis which, in its turn, is in both rotational and translational motion. The complex spiral and cycloidal curves which may be thus obtained present an exceedingly beautiful appearance.

THE *American Engineer and Railroad Journal* gives a full account, of the Japanese Industrial Exhibition opened in Kioto on April 1st. The present exhibition is the fourth of a series instituted in 1877 by imperial ordinance of Japan with the object of encouraging the development of agriculture, the arts and commerce. The former exhibitions were held in Tokio in the years 1877, 1881 and 1890. The fourth exhibition is held on the occasion of the eleven hundredth anniversary of the founding of the city of Kioto by Emperor Kwammu. The site for the exhibition is near the incline of the Lake Biwa Canal. The exhibition grounds are $42\frac{1}{2}$ acres in extent. The buildings, eight in number, occupying an area of 305,388 sq. ft. are as follows: Industrial Building, Machinery Hall, Agricultural and Forest Building, Marine Products Building, Aquarium, Fine Arts Building, Live Stock Building and Ceremonial

Hall. The number of exhibits has increased from 16,703 in 1890 to 170,184 in 1895.

DR. LEBER, Professor of Opthalmology in the University of Heidelberg, has been awarded the Graefe Medal by the Opthalmological Congress recently held at Heidelberg.

THE American Electro-Therapeutic Association held its 5th annual meeting at Toronto on September 3d, 4th and 5th.

THE professorship of geology and mineralogy in the University of Toronto is vacant, owing to the resignation of Prof. Chapman.

PROF. PRICE, Commissioner of Fisheries of the Dominion of Canada, has been examining the coast of British Columbia with a view to finding a suitable place for lobster breeding.

PROFESSOR ADAMKIEWICZ, of Vienna, has been elected correspondent of the Paris Academy of Medicine in recognition of his researches on the nature and treatment of cancer.

DURING the month of September there will be held in Hamburg a meeting of the Society of German Physicians for the Insane, and in Stuttgart the annual meeting of the German Society for Public Hygiene.

MR. WILLIAM KENT has become a member of the editorial staff of *Engineering News*.

DR. ALBERT GÜNTHEE, F. R. S., has resigned his position as Keeper of Zoölogy in the Natural History Museum at South Kensington after having filled it for thirty years.

DR. JOHN SYER BRISTOWE, a London physician who acheived great success as a writer, pathologist and clinical teacher, died recently at Monmouth, at the age of 68. His treatise on the 'Theory and Practice of Medicine' first published in 1876 is regarded as one of the leading text-books on the subject and has passed through many editions. In 1888 he published 'Diseases of the Nervous System,' a collection of papers containing important contributions to neurology.

THERE will be held at Amsterdam on September 20th and 21st an International Congress of Railway and Marine Hygiene. The work of the Congress will be divided into three sections, dealing respectively with the securities for the physical competence of the staffs of railways and ships, the organization of the medical service, and the hygienic interests of employees and travelers.

MR. MARSHALL MCDONALD, Head of the United States Fish Commission, died on September 1st, at the age of 60 years.

PROFESSOR SVENON LOUIS LOVEN, a Sweedish zoölogist, died recently at the age of 86 years.

PROFESSOR HOPPE-SEYLER, of Strassburg, one of the founders of modern physiological chemistry, died on August 12th, at the age of 70.

We learn from the *British Medical Journal* that in the *Ugeskrift for Läger* Dr. Friis advances a claim on behalf of a Holstein schoolmaster named Peter Plett, to the honour of priority in the discovery of vaccination. Jenner's first vacination was, he says, performed on May 14th, 1796, but Plett had already done it in 1791. The latter was a tutor in a family at Schönweide in Holstein in 1790, and while there he heard that it was a matter of common knowledge that the milkmaids who had previously been infected with cow-pox never caught small-pox. Having by chance seen a medical practitioner perform inoculation, Plett conceived the idea that cow-pox lymph might be used for the purpose of conferring protection against small-pox. In 1791 he was at Hasselburg, and an epidemic of cowpox occurring among the cows on a farm, he told the children under his charge to rub their hands with matter from the pus-

tules; as no result followed he himself vaccinated three of them without the consent or knowledge of their parents. He used a table knife for the purpose, making the incisions on the back of the hand, between the thumb and the forefinger. The operation was successful, and a year later, when the other children of the family suffered from small-pox, the three who had been vaccinated by Plett remained free from the disease. There appears to be no record of his having performed other vaccinations.

GINN & Co. announce '*Chemical Experiments—General and Analytical*,' by R. P. Williams, instructor in chemistry in the English High School, Boston. The book contains 100 sets of illustrative experiments, about one-half in general chemistry and one-half in metal and acid analysis.

THE Fifth International Congress for combatting the abuse of alcohol met at Bâle on August 20th, 21st and 23d. The president, M. Heemskirk, the Dutch Minister of State, opened the proceedings by a brief survey of the progress made since the last Congress held at the Hague in 1893. Papers on physiological and psychological effects of alcohol were read and discussed, including an elaborate paper on the effects of different kinds of alcoholic beverages by Dr. Lancelot, delegate of the French Minister of Public Instruction. The second day was devoted to the various anti-alcoholic organizations throughout Europe. On the third day the principal paper discussed the effect of alcoholic abuse in fostering crime. The majority of the members favored total abstinence. Brussels was decided upon as the place of meeting in 1896.

DURING the past ten years the extinction of wolves in France has proceeded rapidly. One hundred and eighty thousand francs were expended by the government in 1894 for the destruction of wolves. In 1895 the total reported is only 2,500 francs. The official reports state that there are now 55 departments where the presence of wolves is very rare.

IT is stated that the report of the death of M. Lucien Bonaparte Wyse is incorrect, his name having been substituted for that of his brother, M. Napoleon Alfred Wyse.

AT the last meeting of the Council of Manchester Museum, Owens' College, as reported in *The Lancet*, the library committee recommended that a grant of £400 per annum be made on condition that the Lancashire and Cheshire County Councils and the local district councils gave £800 a year. As an amendment it was proposed that the £400 should in any case be given.

CORRESPONDENCE.

WINDS AND OCEAN CURRENTS.

THE article by Mr. Bache in a recent number of SCIENCE on the causes of the Gulf Stream brings up a number of points on which other opinions than those which he advocates may be fairly maintained. Some of these points have been indicated by Prof. Le Conte (SCIENCE, Aug. 16). The scheme of a northeast surface movement and southwest subsurface return of an oceanic circulation in the northern hemisphere, if uninterrupted by continents, is essentially a return to the untenable view advocated by Dove in his theory of atmospheric circulation; now displaced by Ferrel's much more satisfactory theory. The deducible circulation of the ocean, under convectional control alone, whether interrupted by continents or not, has been best stated by Ferrel, especially in several articles in SCIENCE, first series, 1886 or 1887; my file is not now at hand for precise reference.

While there is good reason to believe that the difference of density of the equatorial and polar waters produces a slow convectional circulation of the ocean, and is responsible for the low temperature of the great body of the torrid oceans, there is also good reason for thinking that the comparatively rapid and notably systematic, eddy-like circulation of the surface waters in the several oceans is determined essentially by the winds. The argu-

ments for the wind theory, as generally stated, are first, the general accordance of prevailing winds and associated currents; each ocean having its wind eddy only less marked than its current eddy. Second, the periodic variation of the currents in regions of monsoon winds; the type example of this kind being in the Indian Ocean, where, as even Dampier noted two hundred years ago, the currents shift about a month after the winds. Third, the irregular movements of the surface waters under storm winds, which suffice in a day or two to deflect or even to reverse the surface layers of so strong a current as the Gulf Stream off Hatteras. To these facts may be added the hardly less significant behavior of the equatorial counter currents, which increase in area and strength on that side of the equator to which the trade wind from the other hemisphere crosses over as a deflected, monsoon-like wind; the monsoon currents of the Indian Ocean being only special cases of this general rule. The greater velocity of the North Atlantic drift ('North connecting current' in the objectional terminology of the school atlases) in winter than in summer may also be mentioned as a fact best explained by the wind theory. There is nothing about the Gulf Stream so peculiar as to exempt it from the general control exercised by the winds over the waters. W. M. DAVIS.

HARVARD UNIVERSITY.

CORRECTIONS.

EDITOR OF SCIENCE: The fate of my review of Beddard's Zoogeography furnishes another illustration of the dangers which an author is subject to in his path to publication. In the proof (of which I have a duplicate at hand), Nearctic and *Ostolæmus* occur all right, but in the published article (altered after it passed through my hands) *Osteolæmus* is substituted for *Ostolæmus* and *Osteolœmus* for *Osteolæmus* and consequently there is no apparent point to the criticism made and no reason for the analogue educed. 'Upiform' on p. 273 (left column) should have been *pupiform*, and 'even' on p. 273 (right column) just before 'the same Hyracodon' should, of course, have been *event*. The *p* of pupiform and *t* of event were dropped after transmission of the proof; 'molacologist' should have been corrected to *malacologist*.

I may add that Mr. Beddard spells the title of his volume Zoogeography (without ö) as I had written and corrected.

The reviewer of Beddard's work in 'Nature' (July 25, p. 289) is "at a loss to understand" "by what confusion of ideas the name *Hyracodon*, (which belongs to an extinct genus of rhinoceros-like animals) is made to do duty for *Didelphys*." *Hyracodon* of Tomes, as noted in the review in SCIENCE (p. 273) was published in 1863 and in the Proc. Zoöl. Soc. London (p. 50) and has remained unexplained to the present day. I have long been inclined to believe that it was based on a young *Didelphys*, although the meagre description does not apply to any stage I have seen (and I have seen many). I was surprised that it was not noticed in Mr. Thomas' excellent work on Marsupials. It seems, indeed, to have fallen quite flat, but was noticed by Murray in his geographical distribution of Mammals, and I presume that it is from Murray that Mr. Beddard has received the generic name. The homonymy of the names of Leidy and Tomes was, of course, a mere coincidence. The type of Tomes' genus (*Hyracodon fuliginosus*) was from 'Ecuador; collected by Mr. Fraser.' If it has not been lost, perhaps Mr. Thomas may find it and tell us what it is.

We may, perhaps, derive some comfort from the fact that the printers of your famous contemporary 'Nature' are by no means exempt from errors like those I now correct. Four lines before the reference to *Hyracodon* just cited, we find a reference to the 'Siberian hippopotamus;' the original copy of the review undoubtedly had *Liberian*. THEO. GILL.

WASHINGTON, Aug. 31, 1895.

[In the issue of SCIENCE for August 30, smaller type was for the first time used in part of the number. As is apt to happen in such cases there was a delay in the arrival of the type and the proof was late. Dr. Gill's corrections were sent to the printer, but the corrected proof was not seen by the editor. The errors are however such (presumably due to resetting part of the article) that it is better to offer apologies rather then excuses. J. McK. C.]

BOLOMETRIC INVESTIGATIONS; A CORRECTION.

PROF. JOSEPH LE CONTE has kindly called my attention to an error in the above article. On page 175, 7 lines from the bottom of first column, it should read million instead of thousand, and after line 5 insert million, that is, the limits are four hundred million million and seven hundred million million times per second. The error was made in transcribing the original manuscript and was not caught in my proof reading.

WILLIAM HALLOCK.

SCIENTIFIC LITERATURE.

The Growth of U. S. Naval Cadets. By HENRY G. BEYER. (Proceedings of the United States Naval Institute, Vol. XXI., No. 2. Whole No. 74).

In this paper Dr. Henry G. Beyer discusses measurements of U. S. Naval Cadets. These measurements form an exceedingly valuable material for the study of growth. The character of the material may be judged from the following remarks of the author:

"It has been the custom at the Naval Academy for the last thirty years or more to make an annual physical examination of every cadet in training at that school, and, at the same time, to keep a record of certain anthropometric measurements of every cadet undergoing such examination. * * * Up to a few years ago the height standing, perineal height, circumference of chest, waist measure and the lung capacity were the only items recorded. Within recent years the height sitting, span of arms, strength of squeeze, acuteness of vision and hearing have been added to these records; the number of observations under the first-named items is, consequently, much larger than that under the last named. * * * * The cadet who stays the full term of four years at this school leaves on the books the records of five successive examinations taken one year apart; after graduation two years are spent at sea, after which time the cadet returns to the Academy for his final examination, leaving the records of another physical examination. This makes six in all. Since the age for entrance into the Academy is limited to from 15 to 18 years, and taking six years as the time necessary to elapse between the first and last examinations, the period of growth covered by these records ranges all the way from 15 to 24 years of age."*

The most important part of the investigation is the discussion of individual growth which proves beyond a doubt that the assumption which was made by Bowditch and Porter, namely, that on the average individuals of a certain percentile rank retain this rank through life does not hold good. Dr. Beyer considers boys of 15 years of age and representing the 25th and 75th percentile grades. It appears from the tables given by the author that the average statures of both classes approach more and more the 50th percentile grade. I have computed the rank of these boys from year to year from the statements given by Dr. Beyer, and obtained the result that boys who ranked at 15 years 26% and 73% ranked in the following years:

Years	15	16	17	18	19	20	21
Grade	26	28	26	34	27	38	38
Grade	73	74	69	69	68	65	—

It appears that the approach of the lower grade towards the middle is greater than that of the higher grade. In the consideration of weight the approach of the lower grade toward the middle grade appears even stronger, while the higher grade even exceeds the corresponding normal grade. It is difficult to understand the reason of this phenomenon. It would seem likely that when we select a certain grade at a certain age, and follow the development of the individuals composing the grade, that the conditions of life during the following years are favorable in some cases, unfavorable in others, but, on the whole, correspond to the average conditions. When, therefore, the initial age is remote from the adult stage, we should expect a gradual approach to the average. This phenomenon is observed in the case of stature, but does not appear clearly in the case of weight. As Dr. Beyer does not give his original observations, it is impossible to judge what may be the cause of this curious fact.

The same subject is treated in a small but useful table (XVII.), which proves that when a small group of individuals whose statures at

* In addition to these data we should like to know the restrictions governing the selection of cadets which are of great importance in interpreting the observed distribution of measurements.

a certain age lie between narrow limits are treated alone, the variability of the series increases steadily until the adult stage is reached, and that furthermore this increase in variability is the less the nearer the initial point approaches the adult stage. It appears at the same time that each of these series approaches the middle values as time elapses from the initial age.

Another important phenomenon which is brought out in this paper is that tall boys of 16 years grow much less than short boys, because they are nearer the adult stage. As the table which Dr. Beyer gives is rather complex and not quite clear, I have computed it again and give it here in a modified form. I have compensated the series and find that among each 100 boys the following amounts of total growth occur:

Statures at 16 years.		62 and 63 in.	64 and 65 in.	66 and 67 in.	68 and 69 in.
Frequency of various amounts of total growth from 16th to 22d year in inch. among 100 individuals.	—0.9–0.0	—	1	—	2
	+0.0–0.9	3	9	15	14
	1.0–1.9	8	24	*35*	*39*
	2.0–2.9	14	*32*	31	31
	3.0–3.9	17	21	12	12
	4.0–4.9	*18*	10	2	2
	5.0–5.9	17	2	1	—
	6.0–6.9	10	1	3	—
	7.0–7.9	5	—	1	—
	8.0–8.9	6	—	—	—
	9.0–9.9	2	—	—	—

These figures show that the typical amount of growth of the 16-year-old boy who is 62 or 63 inches tall is about 4.4 inches; of the boy who is 64 or 65 inches tall 2.4 inches, and of those from 66 to 69 inches only 1.8 inches. It also shows that the boys grow more uniformly the taller they are, and this is probably the cause of the more rapid approach of the lower grades towards the middle values. The curves showing the total amount of growth are necessarily very assymetrical and the assymetry effects the averages of the statures of the boys who originally belong to the same grade. Therefore these averages which were used by Dr. Beyer in following the growth of a certain group of individuals are only very rough approximations to the typical value of that class. For the 17th year I obtained the following distribution and approximate typical values of growth from the 17th to the 22d year of age:

Stature at 17 years.		64 and 65 in.	66 and 67 in.	68 and 69 in.
Frequency of various amounts of total growth from 17th to 22d year among 100 individuals.	—0.9–0.0	3	5	5
	+0.0–0.9	22	35	42
	1.0–1.9	*31*	*38*	*42*
	2.0–2.9	25	16	9
	3.0–3.9	10	5	1
	4.0–4.9	4	1	1
	5.0–5.9	5	—	—
Typical growth from 17th to 22d year; inches.		1.6	1.0	0.3

This consideration cannot be carried on, because the selection made by the author of individuals of equal stature of 16 years of age influences the distribution of measurements taken during the later years too much.

It appears from these tables that it would be an easy matter to determine in this manner, how many individuals of each class are adult at a certain age, and this is one of the fundamental points required for a better understanding of the laws of growth. But it would have been much better to start with individuals who as adults have the same measurements and to investigate how these measurements are distributed in earlier years. This is the only means by which the difficulties arising from the irregular distribution of the period of growth in different individuals can be overcome.

The investigation suffers greatly from the fact that only a selection—and not a very systematic selection—of data from the rich material has been utilized. The author deserves our special thanks for having given these data in an unabridged form. They are contained in Tables XIV. to XVI., which represent the heights of 63 tall, 71 middle-sized, and 52 short individuals, measured mostly annually from their 16th to their 22d year, but the measurements for the 21st year are missing in most cases. The grouping, however, is not favorable, the limits of the lowest and highest classes being too wide. The shortest class contains individuals of from 60.5

to 65½ inches; the middle-sized group individuals measuring 65 and 66 inches, the tall group individuals of from 67 to 69.5 inches. In arranging such a table either the total material must be utilized or a certain portion selected at random, and the limits which are originally selected must be adhered to most rigidly. Therefore it is not admissible to include in these tables individuals whose measurements at 16 years are not given but whose later development is similar to that of other boys of the class. The deviations of these three tables which are given at the foot of the columns have been miscalculated.

It is very curious that although the paragraphs discussed here show that the theory of percentile grades as applied to the study of growth cannot be held any longer, nevertheless the whole valuable material is presented in this form so that it is all but useless for the purpose of further investigations. The very conclusions which the author draws from his study of individual records prove that all the tables (XXIX. to XLVIII.) which contain the annual increases for the different percentile grades have no biological significance whatever and ought to have been omitted.

Dr. Beyer's investigations show that it is quite indispensable to publish the original records of each individual as the only means of really furthering our knowledge of the laws of growth. Only on such tables can future study be founded, and if there is to be a wholesome advance in the science of anthropometry such tables must be accessible to all. We hope that the author may find an opportunity of extending the brief abstracts of such individual records which are printed in tables XIV. to XVI. and give us the whole valuable material which would represent the most important contribution to the study of growth made for a long time.

FRANZ BOAS.

Untersuchungen über die Stärkekörner; Wesen und Lebensgeschichte der Stärkekörner der höheren Pflanzen. Von ARTHUR MEYER, Professor der Botanik an der Universität Marburg. Mit neun Tafeln und 99 in den Text gedrückten Abbildungen.

As the title suggests, this work contains an exhaustive treatment of the subject. Its principal interest lies in the fact that the manner of origin and growth of the starch grain has been for many years a subject of patient investigation, and different theories respecting the unit of organized structures have been based on the facts thus obtained.

The work is divided into five parts. The first treats of the chemical nature of the starch grain, its relation to the action of the ferment diastase; the second, of the physical character of the grain; the third, of its biology; the fourth consists of biological monographs of the starch grains of various plants; the fifth is a short discussion of the relation of the starch grain to the living protoplast.

In order to make clear the conclusions reached by the author in the first part, it will be necessary to explain that Naegeli was the first to construct a theory concerning the chemical nature of the starch grain, its manner of origin and subsequent growth. Since his book was written many facts have come to light, which have invalidated some of his conclusions. His work, however, forms the basis of all subsequent investigations. He considered the grain made up of two substances which he named starch cellulose and granulose. The latter he thought contained the essential principles of starch, and is that part which is dissolved by the action of saliva on certain acids; the former he supposed differed but little from the substance composing the principal part of the vegetable cell wall, or cellulose; this starch cellulose forms the skeleton or framework left after the grain has been treated with saliva or acids as before described. Later investigators, among whom is Walter Naegeli, claim that the intact grain consists of one substance only, and that the skeleton is the product of the chemical action of the acids on this substance, and they name this product amylodextrine.

According to the results obtained by the author in a long series of experiments, he concludes that the grain consists of one substance, amylose, which exists in two forms or modifications, and a slight amount of another substance, amylodextrine, which is a dissociation product of amylose. The two forms of this latter substance he names for convenience β- and α-

amylose, and says it is quite possible that future investigations will show that β- and α- amylose are crystals of one and the same substance, the former containing water, the latter without. Of the difference between them, he says β-amylose is soluble in water at 100°, while α-amylose requires a greater degree of heat to render it soluble, and that if the starch grain be treated with water at 138° a single substance may be obtained in the form of β- amylose as the α- amylose is changed to this form.

Amylodextrine is said to be of interest for three reasons. First, it exists in those starch grains which turn red with the application of iodine; second, the ordinary starch grain can be easily changed into it; third, because the sphærocrystal of the pure amylodextrine is very important in explaining the real nature of the starch grain. The first discoverer of amylodextrine was Musculus (Comptes rendus 1870, page 857), who named it insoluble dextrine. Its present name was given it by Walter Naegeli, who, with many other scientists, afterwards obtained this substance by treating starch with various acids. The author conducted a series of similar experiments for the purpose of obtaining amylodextrine in a pure form and then to determine its molecular weight. He succeeded in the former, but in the latter attempt only learned with certainty that its molecular weight was very high. He then gives in detail the exact methods and results of a long series of experiments with various substances more or less clearly related to amylodextrine. Among other conclusions concerning it he states that the skeleton of the starch grain, obtained by treating it with saliva or acids, does not consist entirely of amylodextrine as was formerly supposed, but of a mixture of crystals of this substance with crystals of α— amylose. Part first closes with the macro- and micro-chemistry of the starch grain.

In the second chapter he gives a statement of his conclusions concerning the physical constitution of the starch grain, with an explanation of his reasons, then a full account of all the theories preceding his own. It is impossible to give more than a brief summary of the contents of this chapter in the space allotted to a review.

Naegeli's theory, as the author states, was the first which was founded on an extended series of observations, and from the year it was published, 1858, till now, it has been the prevailing theory with most scientists and text-book writers. According to our author, however, it has wrought much harm by introducing the use of the terms, intussusception and apposition as applied to methods of growth, also by the application of the supposed manner and growth of the starch grain to that of cell wall and protoplasts. Schimper, in his work published in 1880 and 1881, was the first to destroy the deep-seated faith in Naegeli's theory. This he did first, by proving that most starch grains are formed in the chromatophores, while the foundation of Naegeli's theory rests on the assumption that the starch grain grows free in the cell sap. Second, Schimper claimed that the inner part of the grain is the older, the outer the younger. His conclusion is that the starch grain is a sphærocrystal composed of fibrous crystalloids, therefore the whole is a crystalloid. The author contrasts the opinions of Naegeli and Schimper as follows: Naegeli supposed the grain to be made up of long crystals lying perpendicular to the layers of stratification, but free in the cell sap. Schimper supposed the crystalloid threads composing the grain to be united at their bases. Naegeli made the spherical bodies or balls, forming the transition between fluid and solid bodies, grow by means of the intercalation of new substances between the old particles; Schimper, by the superposition of new masses of substance. Naegeli explained the layers as resulting from a difference in tension caused by the new particles of substance intercalated between the old, Schimper, by a difference in tension caused by the influx of water between the particles of substance. It is in this particular, and in other characters of the grain which Schimper claimed as a cause for its striations, that his theory differs from that of the author.

According to the latter, the starch grain is a sphærocrystal (not a sphærocrystalloid) composed of crystals of β— and α— amylose and amylodextrine. He defines the word sphærocrystal in the sense in which it was used by Naegeli and Rosenbusch, that is, a microscopically small spherical body with a more or less

plainly radial structure, and more or less clearly marked striations, and which shows a cross when viewed with a polarizer. These bodies exist in the mineral, animal and plant kingdoms, and may be artificially produced from organic or inorganic material. The author claims that the starch grains are sphærocrystals which are exactly similar in structure and action to those of other carbohydrates, with the single exception of their manner of swelling in the formation of paste. This difference he attributes to the peculiarity of the β— amylose crystals, and says it is too unimportant to make a distinction between the starch grain and the sphærocrystal. The typical sphærocrystal consists of very fine, long, needle or thread-like crystals which may be called trichiten. These trichiten are united in clusters and the clusters branch in such a manner as to form pores or channels for the entrance of water. The manner of branching depends upon certain conditions in the way the material by which the crystal grows is furnished. The appearance of stratification is caused by the difference in the size of the pores, and consequently the amount of water in the different layers. In all this the starch grain corresponds to the sphærocrystal of the pure amylodextrine, both bodies enlarging to a certain extent on taking in water. It is otherwise when heat or chemical reagents are used, by which the starch grain is partially dissolved. This he terms 'Lösungsquellung,' a process peculiar to starch and due to the nature of β— amylose. In conclusion he adds, as the structure of the starch grain corresponds to that of the sphærocrystals of other carbohydrates it is highly probable that it grows in the same manner.

The result of the author's investigations concerning the biology of the starch grains must also be condensed into a few sentences. He describes the chromatophore as a drop of a complex viscous fluid solution. In the viscous fluid of this drop the carbohydrates are formed and eventually condensed to amylose, etc. The form of the starch grain depends upon the form of this drop. It is also influenced largely by the diastase which is in the chromatophore itself and works principally from the outside inward so that the grain grows smaller by its action. He claims that starch grains may be formed in the three different kinds of chromatophores, and that in the angiosperms, at least, they never originate free in the cell sap or cytoplasm. He describes the chloroplast as consisting of a colorless or yellowish substance, stroma, in which lay drops of a chlorophyll-colored substance, grana. He suggests that the latter form the apparatus of assimilation, while the stroma produces the starch and is also the organ by which diastase is formed. The growth of the starch grain is said to be influenced considerably by the formation of crystalloids of proteid substances which the chromatophores are known to form. He suggests that the names of the various kinds of grains, given to them by Naegeli, be changed to others more in harmony with their manner of growth. Numerous examples are given from various plants, and the experiments of a large number of scientists are quoted in addition to his own, to explain the cause of rifts and clefts in certain grains, the origin of the layers and many other points.

Finally, he treats of the starch grain as a part of the living protoplast. After contrasting the views of Naegeli and Wiesner by which they formulated hypotheses concerning the organization of the cell, he says both these scientists hold that there is no important difference between the structure of the starch grain and that of protoplasm. An entirely different relation, however, between starch grain and protoplast must be assumed by all who consider the protoplast a fluid. He then quotes from a large number of scientists who agree with him in this opinion of protoplasm.

If this view of the nature of the starch grain be correct, the commonly accepted theory concerning the unit of structure of cell wall and of protoplasm loses its foundation. It is true that the greater part of Naegeli's studies was confined to the starch grain, while other botanists applied these conclusions to the structure and manner of growth of cell wall and even to the unit of structure of the living protoplasm. It is highly probable that, as a German botanist said to the writer of this review, referring to another contested physiological problem, "The last word concerning this subject has not been spoken."

EMILY L. GREGORY.